Access 5 Project Office
NASA
P.O. Box 273
Edwards, CA 93523 USA
661-276-2440
661-276-3880 FAX
www.access5.aero

COVER SHEET
Access 5 Project Deliverable

Deliverable Number: PD010

Title: Recommendations for UAS Crew Ratings

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Abstract:
This position paper is intended to recommend the minimum certificate and rating requirements for a pilot to operate an Unmanned Aircraft System (UAS) in the National Airspace System. The paper will recommend the minimum requirements based on the Knowledge, Skills, and Abilities (KSA) required of a UAS pilot and show how those compare to the KSAs required by regulation for manned-aircraft pilots. The paper will provide substantiation based on studies conducted using analyses, simulation and flight experience. The paper is not yet complete; only initial working material is included. The material provided describes the body of work completed thus far and the plan for remaining tasks to complete the recommendation.

The HSI Pilot KSA document provides an analysis of the knowledge, skills, and abilities required for UAS operation in the NAS. It is the source document used for the position paper.

Status:

WP – Work in Progress Draft

Limitations on use:
The position paper consists of internal working memoranda of Access 5 and has not been subjected to a formal review process. Access 5 makes no claims for the validity of this information. The HSI Pilot KSA document has been reviewed, and represents a substantially complete analysis. Updates may be needed depending on the results of additional analyses, simulations, and flight tests. These documents lay the groundwork for the process that should follow to substantiate a pilot rating recommendation for UAS.

ACCESS 5 POSITION PAPER

Project: Access 5 **Paper Number**: G-XX

Regulation Reference: 14 CFR Part 61

Date:

Status:

Proposal	Draft Position	Closed	SEIT-Approved	Access 5-Approved
X				

Subject: Pilot Ratings and Authorization Requirements for UAS

Statement of Question/Issue:
The qualifications required for pilots operating Unmanned Aircraft System(s) (UAS) have not been defined. Establishment of pilot qualification is required before pilots will be allowed to operate UAS routinely in the National Airspace System (NAS).

Discussion:

Background

Pilots who act as pilot-in-command of an aircraft in the NAS must meet qualification standards described in 14 CFR § 61. Practical Test Standards, issued as Advisory Circulars which support 14 CFR § 61, further detail the knowledge, skills, and abilities that pilot applicants must demonstrate in written and practical tests prior to receiving the required ratings. These rating criteria are well established for manned-aircraft categories and classes, but similar ratings for UAS have not been defined.

Access 5 has been following a process to establish a UAS pilot rating recommendation, as described below.

Access 5 Plan to Validate the Pilot Rating Recommendation

The Access 5 Policy IPT believes that a multi-step process will be required in order to validate the requirements for UAS pilot qualifications. The seven-step process that Access 5 is planning to follow is detailed below. Steps 1. and 2. were completed in CY 2005. The follow-on plan was to complete the remaining steps within one year and then issue a proposal for UAS pilot qualifications.

1. KSA Analysis
   Access 5 studied and documented the pilot Knowledge, Skills and Abilities (KSA) typically expected during operation of a low-autonomy UAS (reference HSI004_Pilot KSA_v2). It drew on the experience of several UAS pilots and referenced a number of military and FAA documents, identifying specific required KSAs by phase of operation, from preflight, through all phases of a ferry scenario, through postflight after landing and shutdown. The complete study provides a fairly detailed basis for analysis of UAS pilot skills and comparison of those skills with existing manned requirements. After review and discussion about the document, we decided to add to the study the specific operational phase representing mission operations – the long-term "loiter" at high altitude inherent in UAS applications – at a high level of autonomy anticipated for equipment operating at high altitudes for long durations. The complete study provided a fairly detailed basis

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for analysis of UAS pilot skills and comparison of those skills with existing manned requirements, item 2 below.

After reviewing the required KSAs for UAS, Access 5 concluded that a reasonable starting point for a minimum manned-aircraft rating for a HALE UAS pilot would be a Private Pilot License with an Instrument Rating. One of the reasons for this conclusion was that this license and rating can provide an entry level for UAS pilots under the current regulatory structure.

2. Comparison of KSA Analysis with Manned Aircraft Regulations
The UAS KSA document was developed for the purpose of identifying all knowledge, skills, and abilities essential to a UAS pilot in performance of a typical mission. By comparing the KSAs of the UAS pilot with the KSAs required of certificated FAA pilots, any excess or deficient training and proficiency of a manned aircraft pilot relative to a UAS pilot should be readily identifiable.

In order to accomplish this comparison, Access 5 broke out the manned aircraft pilot requirements for a Private Pilot with Instrument Rating, since this was a logical starting point for HALE UAS IFR operations, as described above. The manned aircraft regulation that specifies pilot qualifications is 14 CFR 61. Greater detail of expected KSAs is provided in the Practical Test Standards (PTS) that are issued to describe the minimum standards for obtaining a certificate or rating in a practical test. The KSAs derived from the HSI document were compared against the requirements contained within 14 CFR 61 and the associated PTS, starting with requirements for Private Pilot and Instrument Rating.

Access 5 considered whether a separate UA rating should be required for UA pilots.
The benefits of a separate UA rating would be as follows:

- UA pilots wouldn't have to meet manned-aircraft currency requirements.
- Manned aircraft training which has no direct correlation to UA pilot skills could be eliminated (such as Ground Reference Maneuvers).
- The stick-and-rudder skills required for manned-aircraft training may not be directly transferable to most UAS anyway.

The impacts of a separate UA rating would be as follows:

- 14 CFR 61 would have to be rewritten.
- Standards for UA pilot rating would have to be developed.
- Manufacturers and operators may have more difficulty hiring or training qualified UA pilots.

As a result of the comparison of the KSA study with 14 CFR 61, Access 5 believes that there are not sufficient gaps that would require a separate pilot rating for Unmanned Aircraft. However, it may be necessary to develop some documentation of the extra training required of a manned-aircraft pilot transitioning to UA such as a UAS CFI sign-off.

Another conclusion that Access 5 drew from the comparison of the KSA study to 14 CFR 61 is that, although there is some training that does not transfer from the manned-aircraft realm to UA, there is not a huge excess of such training in the requirements for a Private Pilot with an Instrument Rating.

Therefore, one conclusion drawn by Access 5 from this study is that a Private/Instrument rated pilot, given sufficient training on the differences in operation between manned aircraft and the UAS which the pilot wants to operate, should equate to a qualified UAS pilot. No conclusions were drawn about what the training would consist of (whether academics, simulation, flight experience, or all three). This training would have to be designed based on an examination of the gaps in training identified by comparing the KSA study to the knowledge and skills achieved through 14 CFR 61 training.

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The question may arise as to how safe the UAS pilot is to operate in the Class A environment with only the limited experience provided by the Private Pilot with Instrument rating coupled with UAS-specific training. While the question of competence due to lack of experience is legitimate, the fact is that the same pilot is qualified to operate a manned aircraft in Class A airspace with the same lack of experience. As such, this becomes a standards issue rather than a manned-aircraft versus UA issue.

The analysis completed so far by Access 5 has not addressed the issue of whether UAS should be in a separate class of aircraft. In order to perform that analysis, Access 5 would need to develop a list of differences between manned aircraft and UAS and compare those differences with the differences in classes of manned aircraft and determine whether the differences in UAS were sufficient to justify a new class. For instance, it might make sense to have a Private Pilot, Single-Engine Land UAS certificate. Access 5 would have to develop substantiation for this new class before recommending it. The same process would apply to whether UAS should require a type rating to account for individual UAS differences.

As a result of the work completed thus far, Access 5 believes that a Private Pilot certificate with an Instrument rating, coupled with UAS-specific training, provides sufficient qualification for a pilot to operate a HALE UAS in the NAS. Further evaluation needs to be accomplished to determine the training required to qualify a UAS pilot independent of existing pilot qualifications, in particular for non-HALE UAS. Access 5 also believes that the Private Pilot/Instrument with additional UAS training recommendation must be validated before a final recommendation on pilot rating can be made. The Access 5 plan for completing this testing is presented in the next section.

3. Survey of UAS Pilot Qualification Current Practice
The Access 5 will conduct a survey of pilot qualifications in current UAS to gain further insight into the training and proficiency required for operating UAS. The survey will include the HALE UAS manufacturers that are part of UNITE and other foreign and governmental entities with experience in HALE operations. The survey will gather data on the hiring, training, and currency requirements for each operation. The survey will also examine accident and mishap reports in an effort to determine if training or experience was a factor. This survey will capture present practice in UAS operations. This survey will be done with a recognition that current HALE UAS experience is limited to military and research operations.

The information to be gleaned from this survey would include the following:

- What are the minimum flying experience requirements, and how were those developed?
- What data was used for substantiation of the requirements?
- What additional training is required of pilots immediately after hiring/assignment.
- What are the requirements for the pilots to maintain proficiency?
- Mishap analysis as relates to training and experience.

Some of the information required may already be available and should be identified concurrently with step 7.

4. Simulation
Access 5 will perform UAS pilot KSA simulations that will focus on validating UAS unique skills/abilities identified in the KSA analysis. In addition, the task synergy and more realistic task execution timing provided in simulation will assist in identifying any additional, UAS unique, KSA requirements.

The simulations will consist of both scripted, partial flight scenarios designed to isolate selected KSA(s), and multi-flight phase IFR scenarios to look for task synergy issues and some indications of workload-related issues. The scripted scenarios could be accomplished on partial or full-capability control station simulators using a mix of minimally-qualified to highly-experienced UAS pilots, and prerecorded and/or staged external inputs (ATC interaction, aircraft

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performance/response, etc.). The control station simulations will not necessarily be representative of an existing UAS, since the focus is on the pilot KSAs, and not on a specific man-machine interface. The multi-flight phase scenarios will be conducted using full-capability control station simulators using a similar mix of minimally-qualified to highly-experienced UAS pilots, and real-time or near-real time external inputs, including realistic ATC interactions and a selected set of normal and abnormal/emergency UA performance/response. The multi-flight phase simulations should be minimally scripted to expose the dynamics of real-world operations.

The results of the simulations will provide data to validate UAS pilot KSAs and the minimum UAS pilot certificate/rating recommendation. The simulations will also assist in identifying specific KSAs and flight scenarios for flight demonstrations.

The simulations may also be used to validate the unique aspects of class or type difference requirements. In order for this validation to occur, a list will need to be developed that identifies the expected unique characteristics of UAS. The extent of the simulations will depend on the number and type of unique characteristics identified in order to establish a statistically valid sample.

2. Flight Demonstrations
   The actual flight environment provides unique situation/aircraft dynamics that can be difficult to accurately capture/portray with simulations. Data from actual flights of UAS, or optionally-piloted vehicles (OPV) in their UAS mode, will be used to demonstrate specific UAS pilot KSAs that could not be adequately addressed in the simulations and to provide a limited validation of the simulations.

   The flight data will be obtained from UAS or OPV flights dedicated to obtaining KSA/scenario data or from other non-dedicated UAS flights such as operational missions. Some of the flight data could be historical and not from current operations. At a minimum, flight data should be obtained for each flight phase where UAS-unique pilot KSAs have been identified, with a special emphasis in flight phases where the UAS pilot KSAs differ significantly from manned aircraft pilot KSAs. Identification of significant differences in this case could justify a different UAS pilot certificate/rating than manned aircraft.

   The flight environment is more complex than can be practically simulated. Therefore, it is critical prior to flight to establish specific points of interest that can be used as “spot checks” to validate simulation that has been or will be performed.

3. Operational Analysis
   In the aviation sector, the Operational Analysis (OA) is a safety risk assessment technique that focuses on operations carried out by the pilot (operator) during established phases of flight. Each phase of flight becomes an operation to be decomposed into a hierarchy of expected pilot behavior. For Access 5, this hierarchy of expected pilot behavior is to be provided through the development of the HALE UAS pilot Knowledge, Skill and Ability (KSA) requirements applicable to a pilot located in a pseudo-cockpit, i.e.; a Ground Control Station (GCS). This effort will identify the major tasks and subtasks the pilot is expected to perform during a given phase of flight.

   Given this set of behavior for each flight operation, the OA risk assessment process can identify the level of risk based on the set of hazards the pilot may encounter, as well as the accompanying set of potential events the pilot may have to respond to during a given phase of flight. While it is the intent for the UAS to avoid hazards while operating in the NAS, the reality is that an encounter may occur that places additional behavioral demands on the pilot. For higher level risks, the behavior may need to be reassessed, potentially leading to a behavior that has to be supplemented with additional training, a technology solution, and/or perhaps an automated hardware / software solution that takes the pilot out of the loop for a given response. As such, it

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provides a reliable cross-check on the skills and abilities deduced by other analyses (particularly the HSI KSA analysis).

4. Survey of UAS Pilot Qualification Studies
   A survey will be conducted to identify research that has already been conducted on the question of what qualifications a UAS pilot will be required to have. For instance, the Air Force Research Laboratory has conducted three studies since 1998 specifically addressing this topic:
   - *USAF Air Vehicle Operator Training Requirement Study* (AFRL-HE-BR-SR-1998-0001): A survey of RQ-1 Predator pilots which concluded initial qualification training for Predator should approximate Air Force undergraduate pilot training (UPT). The surveyed subjects felt prior manned flight experience was important.
   - *Unmanned Aerial Vehicle Operator Qualifications* (AFRL-HE-AZ-TR-2000-0002): A survey of the military services' qualification and training requirements for UAS pilots. The author concluded differences in qualification and training resulted from differing UAS vehicle performance capabilities which resulted in utilization of different airspaces and thus different regulatory requirements.
   - *Impact of Prior Flight Experience on Learning Predator UAV Operator Skills* (AFRL-HE-AZ-TR-2002-0026): Prospective laboratory study which found 150-200 hours of prior flight training was required to learn the necessary stick and rudder skills to fly Predator. The type of prior flight training had some impact on performance on the laboratory tasks.

   The particular studies listed were all performed with manned pilots. Other studies may give different results from those shown. These and similar studies will be identified and evaluated to help form an overall picture of UAS pilot qualifications as viewed by military, government, and private industry. The results will be compared with the other six methods of validation and factored into the overall pilot qualification recommendation that Access 5 will make.

While this document makes an initial recommendation involving qualification of pilots using manned-aircraft certificates/ratings as a basis, it is not the purpose of this paper to limit the training and qualification of UAS pilots to manned-aircraft only. The qualifications can be met with any training program that results in an acceptable level of pilot qualification.

Attachments:
Matrix of KSA to 14 CFR 61 and PTS Comparison
High Altitude Long Endurance (HALE) Unmanned Aircraft System (UAS) Pilot Knowledge, Skills and Abilities

Project Coordination:

SEIT	Stratcom	ID	PM				

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NASA
P.O. Box 273
Edwards, CA 93523 USA
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Appendix A – Private / Instrument Part 61 Requirements & Practical Test Standards

Part 61 Pilot requirements

	Paragraph	UAS Knowledge	UAS Skill/ Ability	Requirement	Corresponding UAS KSA	Applicability (NC means Not Covered)
1	61.57(c)			Instrument experience for IFR - 6 instrument approaches, holding, intercepting/tracking courses in 6 cal months or Instrument Proficiency Check		
2	61.65(a)			Hold at least a current private pilot certificate with a ... rating appropriate to the instrument rating sought		
3	61.65(b)			Aeronautical knowledge for Instrument rating		
4				(1) Federal Aviation Regulations of this chapter that apply to flight operations under IFR	5,6,21,54,55,74,75,291	
5				(2) Appropriate information that applies to flight operations under IFR in the "Aeronautical Information Manual"	20,27	
6				(3) Air traffic control system and procedures for instrument flight operations	5,8,9,115-118,152,163-165,167-169,267,286	
7				(4) IFR navigation and approaches by use of navigation systems	5,18,22,257,261-266,272,280	
8				(5) Use of IFR en route and instrument approach procedure charts	19,24,26,52,60,61,256,272,275,276,277, 291,313	
9				(6) Procurement and use of aviation weather reports and forecasts ... forecasting weather trends ... and personal observation of weather conditions	31-34,36,38,63,64,251,252-254,285,292	
10				(7) Safe and efficient operation of aircraft under instrument flight rules and conditions	############################	
11				(8) Recognition of critical weather situations and windshear avoidance	193,194,195,198, 31-34,123,251,252-254,293	
12				(9) Aeronautical decision making and judgment	35,37,39,49,66,67,82,282,293,307, 206	
13				(10) Crew resource management, including crew communication and coordination	go look for this	
14	61.65(c)			Instrument flight proficiency		
15				(1) Preflight preparation	7,10,27,29,30,36,42,50-52,56,59,62,63,64,72,73,331	
16				(2) Preflight procedures;	34, 108	
17				(3) Air traffic control clearances and procedures	118,120,152,158,163,167-169,267,273,281,308	

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18		(4) Flight by reference to instruments	91-96,175,258,260,263-266,268,270,274,278,279,280,283,294,295,304,308,314
19		(5) Navigation systems	18,22,170,261,275,315
20		(6) Instrument approach procedures	26, 171, 256,259,270,272,275,276, 277,283,291,296,304,310
21		(7) Emergency operations	300,306
22		(8) Postflight procedures	324,326,329,335
23	61.65(d)	Aeronautical experience	
24		(1) At least 50 hours of cross-country flight time as pilot in command, of which ... 10 hours must be in airplanes for an instrument -- airplane rating	
25		(2) A total of 40 hours of actual or simulated instrument time on the areas of operation of this section, to include--	
26		(i) At least 15 hours of instrument flight training from an authorized instructor in the aircraft category for which the instrument rating is sought;	
27		(ii) At least 3 hours of instrument training ... from an authorized instructor in preparation for the practical test within 60 days...	
28		(iii) For an instrument -- airplane rating, instrument training ... that includes at least one cross-country flight in an airplane that is performed under IFR: 250 nm, 3 kinds of instrument approaches, instrument approach each airport	
29	61.65(e)	Use of flight simulators or flight training devices ... provided by an authorized instructor...	
30		(1) A maximum of 30 hours may be performed in that flight simulator ... in accordance with part 142 of this chapter (20 hours otherwise)	
31	61.103(a)	17 years of age for Private Pilot certificate	
32	61.103(c)	Be able to read, speak, write, and understand the English language.	11,96,97,113,328, 190, 191, 97, 328
33	61.105(b)	Aeronautical knowledge for Private Pilot certificate	1
34		(1) Applicable Federal Aviation Regulations of this chapter that relate to private pilot...	6,54,55,74,75,156,291, 129, 130, 177
35		(2) Accident reporting requirements of the National Transportation Safety Board	
36		(3) Use of the applicable portions of the "Aeronautical Information Manual" and FAA advisory circulars	6,8,9,20,27,102.107,152,153,163, 96, 129, 130, 132, 138, 177
37		(4) Use of aeronautical charts for VFR navigation using pilotage, dead reckoning, and navigation systems	19,23,52,60,61,156

38			(5) Radio communication procedures	91-96,115-118,120,152,158,165,167-169,267,273,281,327, 137, 138, 187, 188, 189, 202, 91, 92, 93, 94, 101, 327
39			(6) Recognition of critical weather situations from the ground and in flight, windshear avoidance, and ... weather reports and forecasts	31-34,38,63,64,251,253,254,285,286,291,292,299, 128, 182,193, 194, 195, 200
40			(7) Safe and efficient operation of aircraft, including collision avoidance, and recognition and avoidance of wake turbulence	############################
41			(8) Effects of density altitude on takeoff and climb performance	28,34,123,293, 128, 193
42			(9) Weight and balance computations	128
43			(10) Principles of aerodynamics, powerplants, and aircraft systems	7, 81, 128, 177, 193
44			(11) Stall awareness, spin entry, spins, and spin recovery techniques for the airplane and glider category ratings	128, 134, 135, 179, 180, 200
45			(12) Aeronautical decision making and judgment	49,66,67,82,161,282,307, 82, 95, 141
46			(13) Preflight action that includes--	27,29,35,37,39
47			(i) How to obtain information on runway lengths ..., data on takeoff and landing distances, weather reports and forecasts, and fuel requirements	10,12-17,28,45-47,63,64,111,123,155,285,293, 185, 193, 197, 201, 202
48			(ii) How to plan for alternatives if the planned flight cannot be completed or delays are encountered.	198, 201, 285,286
49	61.107(b)		Flight Proficiency for Private Pilot certificate	
50			(1) For an airplane category rating with a single-engine class rating:	
51			(i) Preflight preparation;	7,10,50,51,59,72,73,331
52			(ii) Preflight procedures;	102, 99,100,108,110,113
53			(iii) Airport and seaplane base operations;	101, 102, 144, 183, 208, 99,100-107,112,119,120,152,316-323,325,330,331,334,336
54			(iv) Takeoffs, landings, and go-arounds;	144, 149, 208, 111, 151,154,155,160, 161,277,278,283,284,299,301,303,304,308,309,311,312,318
55			(v) Performance maneuvers;	144, 149, 183, 184, 199, 207, 208, 294,295
56			(vi) Ground reference maneuvers;	144, 149, 183, 208
57			(vii) Navigation;	23, 25, 62, 68, 186, 207, 208

58		(viii) Slow flight and stalls;	144, 149, 208
59		(ix) Basic instrument maneuvers;	144, 145, 146, 148?, 149, 183, 184, 208, 268
60		(x) Emergency operations;	78, 144, 147, 150, 183, 184, 199, 203, 207, 208, 111,300
61		(xi) Night operations	74, 144, 183, 208
62		(xii) Postflight procedures	Look for this
63		(2) Additionally for an airplane category rating with a multiengine class rating: Multiengine operations	
64	61.109(a)	Aeronautical experience for Private Pilot single-engine	
65		Log at least 40 hours of flight time that includes at least 20 hours of flight training ... and 10 hours of solo flight training including:	
66		(1) 3 hours of cross-country flight training in a single-engine airplane;	
67		(2) 3 hours of night flight training in a single-engine airplane that includes--	
68		(i) One cross-country flight of over 100 nautical miles total distance; and	
69		(ii) 10 takeoffs and 10 landings to a full stop (with each landing involving a flight in the traffic pattern) at an airport.	
70		(3) 3 hours ... maneuvering an airplane solely by reference to instruments ..., radio communications ..., navigation systems/facilities and radar services...	
71		(4) 3 hours of flight training in preparation for the practical test ... within 60 days preceding the date of the test	
72		(5) 10 hours of solo flight time in a single-engine airplane, consisting of at least--	
73		(i) 5 hours of solo cross-country time;	
74		(ii) One solo cross-country flight of at least 150 nautical miles total distance, with full-stop landings at a minimum of three points...	
75		(iii) Three takeoffs and three landings to a full stop (with each landing involving a flight in the traffic pattern) at an airport with an operating control tower.	
76	61.109(b)	Aeronautical experience for Private Pilot multiengine - same as single-engine except in a multiengine aircraft	

Practical Test Standards - Private Pilot

		Special Emphasis Areas - Examiners shall place special emphasis upon areas of aircraft operations considered critical to flight safety.	
77		1. positive aircraft control;	99, 100, 114, 144, 149, 183, 204, 205
78		2. procedures for positive exchange of flight controls (who is flying the airplane);	144, 183, 204, 205, 206, 207

79	3. stall/spin awareness;	135, 144, 180
80	4. collision avoidance;	Look for this
81	5. wake turbulence avoidance;	269, 271, 290, 295
82	6. Land and Hold Short Operations (LAHSO);	153, 159, 173, 288
83	7. runway incursion avoidance;	
84	8. controlled flight into terrain (CFIT);	132
85	9. aeronautical decision making (ADM);	121, 141, 208, 35
86	10. checklist usage; and	113, 125
87	11. other areas deemed appropriate to any phase of the practical test	
	I. PREFLIGHT PREPARATION	
	! A. Certificates and Documents	
88	1. Explaining—	
89	a. private pilot certificate privileges, limitations, and recent flight experience requirements.	1
90	b. medical certificate class and duration.	2
91	c. pilot logbook or flight records.	3
92	2. Locating and explaining—	
93	a. airworthiness and registration certificates.	
94	b. operating limitations, placards, instrument markings, and POH/AFM.	4, 73
95	c. weight and balance data and equipment list.	
	! B. Airworthiness Requirements	
96	1. Explaining—	
97	a. required instruments and equipment for day/night VFR.	74
98	b. procedures and limitations for determining airworthiness of the airplane with inoperative instruments and equipment with and without an MEL.	9, 75
99	c. requirements and procedures for obtaining a special flight permit.	
100	2. Locating and explaining—	
101	a. airworthiness directives.	
102	b. compliance records.	
103	c. maintenance/inspection requirements.	
104	d. appropriate record keeping.	
	! C. Weather Information	

105		1. Exhibits knowledge of the elements related to weather information by analyzing weather reports, charts, and forecasts from various sources with emphasis on—	251, 253, 292, 31	
106		a. METAR, TAF, and FA.	31	
107		b. surface analysis chart.	31	
108		c. radar summary chart.	31	
109		d. winds and temperature aloft chart.	33	
110		e. significant weather prognostic charts.		
111		f. convective outlook chart.		
112		g. AWOS, ASOS, and ATIS reports.		
113		2. Makes a competent “go/no-go” decision based on available weather information.	254 293, 17	
		! D. Cross-Country Flight Planning		
114		1. Exhibits knowledge of the elements related to cross-country flight planning by presenting and explaining a pre-planned VFR crosscountry flight, as previously assigned by the examiner. On the day of the practical test, the final flight plan shall be to the first fuel stop, based on maximum allowable passengers, baggage, and/or cargo loads using real-time weather.	51, 12, 33	
115		2. Uses appropriate and current aeronautical charts.	19	
116		3. Properly identifies airspace, obstructions, and terrain features.	24, 331	
117		4. Selects easily identifiable en route checkpoints.	24?	NC
118		5. Selects most favorable altitudes considering weather conditions and equipment capabilities.	32	
119		6. Computes headings, flight time, and fuel requirements.	10?	NC
120		7. Selects appropriate navigation system/facilities and communication frequencies.	22	
121		8. Applies pertinent information from NOTAMs, AF/D, and other flight publications.	27, 331	
122		9. Completes a navigation log and simulates filing a VFR flight plan.		NC
		! E. National Airspace System		
123		1. Basic VFR weather minimums—for all classes of airspace.	174, 291	
124		2. Airspace classes—their operating rules, pilot certification, and airplane equipment requirements for Class A, B, C, D, E, and G.	54, 74	
125		3. Special use and other airspace areas.	55	
		! F. Performance and Limitations		

126		1. Exhibits knowledge of the elements related to performance and limitations by explaining the use of charts, tables, and data to determine performance and the adverse effects of exceeding limitations.	41, 72, 77, 80, 109, 122, 124
127		2. Computes weight and balance. Determines the computed weight and center of gravity is within the airplane's operating limitations and if the weight and center of gravity will remain within limits during all phases of flight.	72, 77, 297, 60?
128		3. Demonstrates use of the appropriate performance charts, tables, and data.	72, 77, 80, 109, 124, 41?
129		4. Describes the effects of atmospheric conditions on the airplane's performance.	72, 77, 109, 122, 123, 299?, 36
		! G. Operation of Systems	
130		1. Primary flight controls and trim.	76, 77, 83, 84, 87, 99, 100, 104, 109, 151, 162
131		2. Flaps, leading edge devices, and spoilers.	76, 77, 84, 87, 104, 109, 151, 162
132		3. Water rudders (ASES).	76, 77, 84, 87, 104, 109
133		4. Powerplant and propeller.	76, 77, 84, 87, 104, 109, 162
134		5. Landing gear.	76, 77, 84, 87, 99, 104, 109, 162, 312
135		6. Fuel, oil, and hydraulic.	76, 77, 84, 87, 104, 109, 162
136		7. Electrical.	76, 77, 79, 83, 84, 87, 89, 104, 109, 162
137		8. Avionics	76, 77, 79, 80, 83, 84, 85, 87, 104, 109, 126, 127, 162, 170, 83?
138		9. Pitot-static vacuum/pressure and associated flight instruments.	76, 77, 84, 87, 104, 109, 162
139		10. Environmental.	76, 77, 84, 87, 104, 109, 162
140		11. Deicing and anti-icing.	76, 77, 84, 87, 104, 109, 162, 34?
		! J. Aeromedical Factors	
141		1. The symptoms, causes, effects, and corrective actions of the following—	71
142		a. hypoxia.	71
143		b. hyperventilation.	71
144		c. middle ear and sinus problems.	71
145		d. spatial disorientation.	71
146		e. motion sickness.	71
147		f. carbon monoxide poisoning.	71

148		g. stress and fatigue.	70, 71	
149		h. dehydration.	71	
150		2. The effects of alcohol, drugs, and over-the-counter medications.	69, 71	
151		3. The effects of excess nitrogen during scuba dives upon a pilot or passenger in flight.	71	
		II. PREFLIGHT PROCEDURES		
		! A. Preflight Inspection		
152		1. Exhibits knowledge of the elements related to preflight inspection. This shall include which items must be inspected, the reasons for checking each item, and how to detect possible defects.	125	
153		2. Inspects the airplane with reference to an appropriate checklist.	125	
154		3. Verifies the airplane is in condition for safe flight.	82	
		! B. Cockpit Management		
155		1. Exhibits knowledge of the elements related to cockpit management procedures.		
156		2. Ensures all loose items in the cockpit and cabin are secured.		NC
157		3. Organizes material and equipment in an efficient manner so they are readily available.		NC
158		4. Briefs occupants on the use of safety belts, shoulder harnesses, doors, and emergency procedures.		NC
		! C. Engine Starting		
159		1. Exhibits knowledge of the elements related to recommended engine starting procedures. This shall include the use of an external power source, hand propping safety, and starting under various atmospheric conditions.	76, 86, 87, 89, 90	
160		2. Positions the airplane properly considering structures, surface conditions, other aircraft, and the safety of nearby persons and property.	86, 90	
161		3. Utilizes the appropriate checklist for starting procedure.	76, 86, 87, 88, 90, 125	
		! D. Taxiing		
162		1. Exhibits knowledge of the elements related to safe taxi procedures.	98, 99, 103, 104, 319, 83?	
163		2. Performs a brake check immediately after the airplane begins moving.	98, 99, 103, 319?	
164		3. Positions the flight controls properly for the existing wind conditions.	98, 100, 103, 319?	
165		4. Controls direction and speed without excessive use of	98, 103, 319?	

		brakes.		
166		5. Complies with airport/taxiway markings, signals, ATC clearances, and instructions.	98, 103, 106, 319	
167		6. Taxies so as to avoid other aircraft and hazards.	98, 105, 319, 103?	
		! F. Before Takeoff Check		
168		1. Exhibits knowledge of the elements related to the before takeoff check. This shall include the reasons for checking each item and how to detect malfunctions.	76, 79, 84, 87, 108, 110, 157, 109	
169		2. Positions the airplane properly considering other aircraft/vessels, wind and surface conditions.	108	
170		3. Divides attention inside and outside the cockpit.	108	
171		4. Ensures that engine temperature and pressure are suitable for runup and takeoff.	108, 161?	
172		5. Accomplishes the before takeoff checklist and ensures the airplane is in safe operating condition.	85, 88, 108, 151, 157	
173		6. Reviews takeoff performance airspeeds, takeoff distances, departure, and emergency procedures.	108, 111, 155	
174		7. Avoids runway incursions and/or ensures no conflict with traffic prior to taxiing into takeoff position.	108, 112, 119, 84?	
		III. AIRPORT AND SEAPLANE BASE OPERATIONS		
		! A. Radio Communications and ATC Light Signals		
175		1. Exhibits knowledge of the elements related to radio communications and ATC light signals.	115-118, 120, 152, 91	
176		2. Selects appropriate frequencies.	115-118, 120, 152, 166, 92	
177		3. Transmits using recommended phraseology.	115-118, 120, 152, 94	
178		4. Acknowledges radio communications and complies with instructions.	115-118, 120, 152, 158, 163?, 118, 95?	
		! B. Traffic Patterns		
179		1. Exhibits knowledge of the elements related to traffic patterns. This shall include procedures at airports with and without operating control towers, prevention of runway incursions, collision avoidance, wake turbulence avoidance, and wind shear.	107, 153?, 156?, 159?, 173? 16?	
180		2. Complies with proper traffic pattern procedures.	107	
181		3. Maintains proper spacing from other aircraft.	141, 142	
182		4. Corrects for wind drift to maintain the proper ground track.	142	NC
183		5. Maintains orientation with the runway/landing area in use.	142	
184		6. Maintains traffic pattern altitude, ±100 feet (30 meters), and the appropriate airspeed, ±10 knots.	144	

		! C. Airport/Seaplane Base, Runway, and Taxiway Signs,Markings, and Lighting		
185		1. Exhibits knowledge of the elements related to airport/seaplane base, runway, and taxiway operations with emphasis on runway incursion avoidance.	13?	NC
186		2. Properly identifies and interprets airport/seaplane base, runway, and taxiway signs, markings, and lighting.	13?	NC
		IV. TAKEOFFS, LANDINGS, AND GO-AROUNDS		
		! A. Normal and Crosswind Takeoff and Climb		
187		1. Exhibits knowledge of the elements related to a normal and crosswind takeoff, climb operations, and rejected takeoff procedures.	154	
188		2. Positions the flight controls for the existing wind conditions.	154	
189		3. Clears the area; taxies into the takeoff position and aligns the airplane on the runway center/takeoff path.	154	
190		4. Retracts the water rudders, as appropriate, (ASES) and advances the throttle smoothly to takeoff power.	154	
191		5. Establishes and maintains the most efficient planing/lift-off attitude and corrects for porpoising and skipping (ASES).		NC
192		6. Lifts off at the recommended airspeed and accelerates to VY.	154, 155	
193		7. Establishes a pitch attitude that will maintain VY +10/-5 knots.	155	
194		8. Retracts the landing gear, if appropriate, and flaps after a positive rate of climb is established.	151	
195		9. Maintains takeoff power and VY +10/-5 knots to a safe maneuvering altitude.	172	
196		10. Maintains directional control and proper wind-drift correction throughout the takeoff and climb.	154, 160	
197		11. Complies with noise abatement procedures.		NC
198		12. Completes the appropriate checklist.	140	
		! B. Normal and Crosswind Approach and Landing		
199		1. Exhibits knowledge of the elements related to a normal and crosswind takeoff, climb operations, and rejected takeoff procedures.	154, 303	
200		2. Adequately surveys the intended landing area (ASES).		NC
201		3. Considers the wind conditions, landing surface, obstructions, and selects a suitable touchdown point.	299, 303	NC
202		4. Establishes the recommended approach and landing configuration and airspeed, and adjusts pitch attitude and	274	

		power as required.		
203		5. Maintains a stabilized approach and recommended airspeed, or in its absence, not more than 1.3 VSO, +10/-5 knots, with wind gust factor applied.	314	
204		6. Makes smooth, timely, and correct control application during the roundout and touchdown.	314	
205		7. Contacts the water at the proper pitch attitude (ASES).		NC
206		8. Touches down smoothly at approximate stalling speed (ASEL).	314	
207		9. Touches down at or within 400 feet (120 meters) beyond a specified point, with no drift, and with the airplane's longitudinal axis aligned with and over the runway center/landing path.	314	
208		10. Maintains crosswind correction and directional control throughout the approach and landing sequence.	278, 284, 301, 303, 318	
209		11. Completes the appropriate checklist.	140	
		! C. Soft-Field Takeoff and Climb		
210		1. Exhibits knowledge of the elements related to a soft-field takeoff and climb.	Knowledge vs. Skill	NC
211		2. Positions the flight controls for existing wind conditions and to maximize lift as quickly as possible.		NC
212		3. Clears the area; taxies onto the takeoff surface at a speed consistent with safety without stopping while advancing the throttle smoothly to takeoff power.		NC
213		4. Establishes and maintains a pitch attitude that will transfer the weight of the airplane from the wheels to the wings as rapidly as possible.		NC
214		5. Lifts off at the lowest possible airspeed and remains in ground effect while accelerating to VX or VY, as appropriate.		NC
215		6. Establishes a pitch attitude for VX or VY, as appropriate, and maintains selected airspeed +10/-5 knots, during the climb.		NC
216		7. Retracts the landing gear, if appropriate, and flaps after clear of any obstacles or as recommended by the manufacturer.		NC
217		8. Maintains takeoff power and VX or VY +10/-5 knots to a safe maneuvering altitude.		NC
218		9. Maintains directional control and proper wind-drift correction throughout the takeoff and climb.		NC
219		10. Completes the appropriate checklist.		NC
		! D. Soft-Field Approach and Landing		

220		1. Exhibits knowledge of the elements related to a soft-field approach and landing.	Knowledge vs. Skill	NC
221		2. Considers the wind conditions, landing surface and obstructions, and selects the most suitable touchdown area.		NC
222		3. Establishes the recommended approach and landing configuration, and airspeed; adjusts pitch attitude and power as required.		NC
223		4. Maintains a stabilized approach and recommended airspeed, or in its absence not more than 1.3 VSO, +10/-5 knots, with wind gust factor applied.		NC
224		5. Makes smooth, timely, and correct control application during the roundout and touchdown.		NC
225		6. Touches down softly with no drift, and with the airplane's longitudinal axis aligned with the runway/landing path.		NC
226		7. Maintains crosswind correction and directional control throughout the approach and landing sequence.		NC
227		8. Maintains proper position of the flight controls and sufficient speed to taxi on the soft surface.		NC
228		9. Completes the appropriate checklist.		NC
		! E. Short-Field Takeoff and Maximum Performance Climb		
229		1. Exhibits knowledge of the elements related to a short-field (confined area ASES) takeoff and maximum performance climb.	151, 154, 155	
230		2. Positions the flight controls for the existing wind conditions; sets the flaps as recommended.	160, 161, 162	
231		3. Clears the area; taxies into takeoff position utilizing maximum available takeoff area and aligns the airplane on the runway center/takeoff path.	160, 161, 162	
232		4. Selects an appropriate take off path for the existing conditions (ASES).		
233		5. Applies brakes (if appropriate), while advancing the throttle smoothly to takeoff power.	160, 161, 162	
234		6. Establishes and maintains the most efficient planing/lift-off attitude and corrects for porpoising and skipping (ASES).		
235		7. Lifts off at the recommended airspeed, and accelerates to the recommended obstacle clearance airspeed or VX.	160, 161, 162	
236		8. Establishes a pitch attitude that will maintain the recommended obstacle clearance airspeed, or VX,+10/-5 knots, until the obstacle is cleared, or until the airplane is 50 feet (20 meters) above the surface.	160, 161, 162	

237		9. After clearing the obstacle, establishes the pitch attitude for VY, accelerates to VY, and maintains VY, +10/-5 knots, during the climb.	160, 161, 162
238		10. Retracts the landing gear, if appropriate, and flaps after clear of any obstacles or as recommended by manufacturer.	160, 161, 162
239		11. Maintains takeoff power and VY +10/-5 to a safe maneuvering altitude.	160, 161, 162
240		12. Maintains directional control and proper wind-drift correction throughout the takeoff and climb.	160, 161, 162
241		13. Completes the appropriate checklist.	157
		! F. Short-Field Approach and Landing	
242		1. Exhibits knowledge of the elements related to a short-field (confined area ASES) approach and landing.	314
243		2. Adequately surveys the intended landing area (ASES).	
244		3. Considers the wind conditions, landing surface, obstructions, and selects the most suitable touchdown point.	318
245		4. Establishes the recommended approach and landing configuration and airspeed; adjusts pitch attitude and power as required.	318
246		5. Maintains a stabilized approach and recommended approach airspeed, or in its absence not more than 1.3 VSO, +10/-5 knots, with wind gust factor applied.	318
247		6. Makes smooth, timely, and correct control application during the roundout and touchdown.	318
248		7. Selects the proper landing path, contacts the water at the minimum safe airspeed with the proper pitch attitude for the surface conditions (ASES).	
249		8. Touches down smoothly at minimum control airspeed (ASEL).	318
250		9. Touches down at or within 200 feet (60 meters) beyond a specified point, with no side drift, minimum float and with the airplane's longitudinal axis aligned with and over the runway center/landing path.	318
251		10. Maintains crosswind correction and directional control throughout the approach and landing sequence.	318
252		11. Applies brakes, (ASEL) or elevator control (ASEs), as necessary, to stop in the shortest distance consistent with safety.	318
253		12. Completes the appropriate checklist.	318
		! K. Forward Slip to a Landing	

254		1. Exhibits knowledge of the elements related to forward slip to a landing.	314	
255		2. Considers the wind conditions, landing surface and obstructions, and selects the most suitable touchdown point.	318	
256		3. Establishes the slipping attitude at the point from which a landing can be made using the recommended approach and landing configuration and airspeed; adjusts pitch attitude and power as required.	318	
257		4. Maintains a ground track aligned with the runway center/landing path and an airspeed, which results in minimum float during the roundout.	318	
258		5. Makes smooth, timely, and correct control application during the recovery from the slip, the roundout, and the touchdown.	318	
259		6. Touches down smoothly at the approximate stalling speed, at or within 400 feet (120 meters) beyond a specified point, with no side drift, and with the airplane's longitudinal axis aligned with and over the runway center/landing path.	318	
260		7. Maintains crosswind correction and directional control throughout the approach and landing sequence.	318	
261		8. Completes the appropriate checklist.	318	
		! L. Go-Around/Rejected Landing		
262		1. Exhibits knowledge of the elements related to a go-around/rejected landing.	311	
263		2. Makes a timely decision to discontinue the approach to landing.	311	
264		3. Applies takeoff power immediately and transitions to climb pitch attitude for VY, and maintains VY+10/-5 knots.	309	
265		4. Retracts the flaps as appropriate.	309	
266		5. Retracts the landing gear, if appropriate, after a positive rate of climb is established.	309	
267		6. Maneuvers to the side of the runway/landing area to clear and avoid conflicting traffic.		NC
268		7. Maintains takeoff power VY +10/-5 to a safe maneuvering altitude.		NC
269		8. Maintains directional control and proper wind-drift correction throughout the climb.		NC
270		9. Completes the appropriate checklist.		NC
		V. PERFORMANCE MANEUVER		
271		! Steep Turns	144, 149, 183	
272		1. Exhibits knowledge of the elements related to steep turns.	144, 149, 183	

273		2. Establishes the manufacturer's recommended airspeed or if one is not stated, a safe airspeed not to exceed VA.	144, 149, 183	
274		3. Rolls into a coordinated 360° turn; maintains a 45° bank.	Max bank for particular UAS, 144, 149, 183	
275		4. Performs the task in the opposite direction, as specified by the examiner.	144, 149, 183	
276		5. Divides attention between airplane control and orientation.	144, 149, 183	
277		6. Maintains the entry altitude, ±100 feet (30 meters), airspeed, ±10 knots, bank, ±5°; and rolls out on the entry heading, ±10°.	144, 149, 183	
		VI. GROUND REFERENCE MANEUVERS		NC
		! A. Rectangular Course		
278		1. Exhibits knowledge of the elements related to a rectangular course.		
279		2. Selects a suitable reference area.		
280		3. Plans the maneuver so as to enter a left or right pattern, 600 to 1,000 feet AGL (180 to 300 meters) at an appropriate distance from the selected reference area, 45° to the downwind leg.		
281		4. Applies adequate wind-drift correction during straight-and-turning flight to maintain a constant ground track around the rectangular reference area.		
282		5. Divides attention between airplane control and the ground track while maintaining coordinated flight.		
283		6. Maintains altitude, ±100 feet (30 meters); maintains airspeed, ±10 knots.		
		! B. S-Turns		
284		1. Exhibits knowledge of the elements related to S-turns.		
285		2. Selects a suitable ground reference line.		
286		3. Plans the maneuver so as to enter at 600 to 1,000 feet (180 to 300 meters) AGL, perpendicular to the selected reference line.		
287		4. Applies adequate wind-drift correction to track a constant radius turn on each side of the selected reference line.		
288		5. Reverses the direction of turn directly over the selected reference line.		
289		6. Divides attention between airplane control and the ground track while maintaining coordinated flight.		
290		7. Maintains altitude, ±100 feet (30 meters); maintains airspeed, ±10 knots.		
		! C. Turns Around a Point		
291		1. Exhibits knowledge of the elements related to turns around a point.		
292		2. Selects a suitable ground reference point.		

293		3. Plans the maneuver so as to enter left or right at 600 to 1,000 feet (180 to 300 meters) AGL, at an appropriate distance from the reference point.	
294		4. Applies adequate wind-drift correction to track a constant radius turn around the selected reference point.	
295		5. Divides attention between airplane control and the ground track while maintaining coordinated flight.	
296		6. Maintains altitude, ±100 feet (30 meters); maintains airspeed, ±10 knots.	
		VII. NAVIGATION	
		! A. Pilotage and Dead Reckoning	
297		1. Exhibits knowledge of the elements related to pilotage and dead reckoning.	200, 201, 202
298		2. Follows the preplanned course by reference to landmarks.	
299		3. Identifies landmarks by relating surface features to chart symbols.	
300		4. Navigates by means of precomputed headings, groundspeeds, and elapsed time.	186
301		5. Corrects for and records the differences between preflight groundspeed and heading calculations and those determined en route.	186
302		6. Verifies the airplane's position within three (3) nautical miles of the flight-planned route.	
303		7. Arrives at the en route checkpoints within five (5) minutes of the initial or revised ETA and provides a destination estimate.	
304		8. Maintains the appropriate altitude, ±200 feet (60 meters) and headings, ±15°.	133
		! B. Navigation Systems and Radar Services	
305		1. Exhibits knowledge of the elements related to navigation systems and radar services.	201, 202, 261
306		2. Demonstrates the ability to use an airborne electronic navigation system.	261
307		3. Locates the airplane's position using the navigation system.	261
308		4. Intercepts and tracks a given course, radial or bearing, as appropriate.	261
309		5. Recognizes and describes the indication of station passage, if appropriate.	145
310		6. Recognizes signal loss and takes appropriate action.	145, 150
311		7. Uses proper communication procedures when utilizing radar services.	267, 273
312		8. Maintains the appropriate altitude, ±200 feet (60 meters) and headings ±15°.	268

			! C. Diversion		
313			1. Exhibits knowledge of the elements related to diversion.	137, 200, 201	
314			2. Selects an appropriate alternate airport and route.	193, 197, 198	
315			3. Makes an accurate estimate of heading, groundspeed, arrival time, and fuel consumption to the alternate airport.	200 203	
316			4. Maintains the appropriate altitude, ±200 feet (60 meters) and heading, ±15°.	203	
317			! D. Lost Procedures		
318			1. Exhibits knowledge of the elements related to lost procedures.	200	
319			2. Selects an appropriate course of action.	200	
320			3. Maintains an appropriate heading and climbs, if necessary.	203	
321			4. Identifies prominent landmarks.		NC
322			5. Uses navigation systems/facilities and/or contacts an ATC facility for assistance, as appropriate.	137, 202	
			VIII. SLOW FLIGHT AND STALLS		
			! A. Maneuvering During Slow Flight		
323			1. Exhibits knowledge of the elements related to maneuvering during slow flight.	128	
324			2. Selects an entry altitude that will allow the task to be completed no lower than 1,500 feet (460 meters) AGL.		
325			3. Establishes and maintains an airspeed at which any further increase in angle of attack, increase in load factor, or reduction in power, would result in an immediate stall.		
326			4. Accomplishes coordinated straight-and-level flight, turns, climbs, and descents with landing gear and flap configurations specified by the examiner.		
327			5. Divides attention between airplane control and orientation.		
328			6. Maintains the specified altitude, ±100 feet (30 meters); specified heading, ±10°; airspeed, +10/−0 knots; and specified angle of bank, ±10°.		
			! B. Power-Off Stalls		
329			1. Exhibits knowledge of the elements related to power-off stalls.	128, 135	
330			2. Selects an entry altitude that allows the task to be completed no lower than 1,500 feet (460 meters) AGL.		
331			3. Establishes a stabilized descent in the approach or landing configuration, as specified by the examiner.		
332			4. Transitions smoothly from the approach or landing attitude to a pitch attitude that will induce a stall.		

333		5. Maintains a specified heading, ±10°, in straight flight; maintains a specified angle of bank not to exceed 20°, ±10°; in turning flight, while inducing the stall.	
334		6. Recognizes and recovers promptly after the stall occurs by simultaneously reducing the angle of attack, increasing power to maximum allowable, and leveling the wings to return to a straightand-level flight attitude with a minimum loss of altitude appropriate for the airplane.	
335		7. Retracts the flaps to the recommended setting; retracts the landing gear, if retractable, after a positive rate of climb is established.	
336		8. Accelerates to VX or VY speed before the final flap retraction; returns to the altitude, heading, and airspeed specified by the examiner.	
		! C. Power-On Stalls	
337		1. Exhibits knowledge of the elements related to power-on stalls.	128, 135
338		2. Selects an entry altitude that allows the task to be completed no lower than 1,500 feet (460 meters) AGL.	
339		3. Establishes the takeoff or departure configuration. Sets power to no less than 65 percent available power.	
340		4. Transitions smoothly from the takeoff or departure attitude to the pitch attitude that will induce a stall.	
341		5. Maintains a specified heading, ±10°, in straight flight; maintains a specified angle of bank not to exceed 20°, ±10°, in turning flight, while inducing the stall.	
342		6. Recognizes and recovers promptly after the stall occurs by simultaneously reducing the angle of attack, increasing power as appropriate, and leveling the wings to return to a straight-and-level flight attitude with a minimum loss of altitude appropriate for the airplane.	
343		7. Retracts the flaps to the recommended setting; retracts the landing gear if retractable, after a positive rate of climb is established.	
344		8. Accelerates to VX or VY speed before the final flap retraction; returns to the altitude, heading, and airspeed specified by the examiner.	
		! D. Spin Awareness	
345		1. Aerodynamic factors related to spins.	180, 128, 135
346		2. Flight situations where unintentional spins may occur.	180, 128, 135, 134
347		3. Procedures for recovery from unintentional spins.	179, 180, 128, 135, 134
		IX. BASIC INSTRUMENT MANEUVERS	
		! A. Straight-and-Level Flight	

348		1. Exhibits knowledge of the elements related to attitude instrument flying during straight-and-level flight.	177, 181, 175?
349		2. Maintains straight-and-level flight solely by reference to instruments using proper instrument cross-check and interpretation, and coordinated control application.	184, 175?
350		3. Maintains altitude, ±200 feet (60 meters); heading, ±20°; and airspeed, ±10 knots.	184
		! B. Constant Airspeed Climbs	
351		1. Exhibits knowledge of the elements related to attitude instrument flying during constant airspeed climbs.	177, 181
352		2. Establishes the climb configuration specified by the examiner.	184
353		3. Transitions to the climb pitch attitude and power setting on an assigned heading using proper instrument cross-check and interpretation, and coordinated control application.	184
354		4. Demonstrates climbs solely by reference to instruments at a constant airspeed to specific altitudes in straight flight and turns.	184
355		5. Levels off at the assigned altitude and maintains that altitude, ±200 feet (60 meters); maintains heading, ±20°; maintains airspeed, ±10 knots.	184
		! C. Constant Airspeed Descents	
356		1. Exhibits knowledge of the elements related to attitude instrument flying during constant airspeed descents.	177, 181
357		2. Establishes the descent configuration specified by the examiner.	184
358		3. Transitions to the descent pitch attitude and power setting on an assigned heading using proper instrument cross-check and interpretation, and coordinated control application.	184
359		4. Demonstrates descents solely by reference to instruments at a constant airspeed to specific altitudes in straight flight and turns.	184
360		5. Levels off at the assigned altitude and maintains that altitude, ±200 feet (60 meters); maintains heading, ±20°; maintains airspeed, ±10 knots.	184
		! D. Turns to Headings	
361		1. Exhibits knowledge of the elements related to attitude instrument flying during turns to headings.	177, 181
362		2. Transitions to the level-turn attitude using proper instrument crosscheck and interpretation, and coordinated control	184

		application.	
363		3. Demonstrates turns to headings solely by reference to instruments; maintains altitude, ±200 feet (60 meters); maintains a standard rate turn and rolls out on the assigned heading, ± 10°; maintains airspeed, ±10 knots.	184
		! E. Recovery from Unusual Flight Attitudes	
364		1. Exhibits knowledge of the elements related to attitude instrument flying during unusual attitudes.	179
365		2. Recognizes unusual flight attitudes solely by reference toinstruments; recovers promptly to a stabilized level flight attitude using proper instrument cross-check and interpretation and smooth, coordinated control application in the correct sequence.	184
		! F. Radio Communications, Navigation Systems/Facilities, and Radar Services	
366		1. Exhibits knowledge of the elements related to radio communications, navigation systems/facilities, and radar services available for use during flight solely by reference to instruments.	177, 181
367		2. Selects the proper frequency and identifies the appropriate facility.	191, 192, 189, 188, 187
368		3. Follows verbal instructions and/or navigation systems/facilities for guidance.	188, 191
369		4. Determines the minimum safe altitude.	60, 61
370		5. Maintains altitude, ±200 feet (60 meters); maintains heading, ±20°; maintains airspeed, ±10 knots.	268
		X. EMERGENCY OPERATIONS (ASEL)	
371		! A. Emergency Approach and Landing (Simulated)	121
372		1. Exhibits knowledge of the elements related to emergency approach and landing procedures.	300, 306
373		2. Analyzes the situation and selects an appropriate course of action.	121
374		3. Establishes and maintains the recommended best-glide airspeed, ±10 knots.	300, 279
375		4. Selects a suitable landing area.	121
376		5. Plans and follows a flight pattern to the selected landing area considering altitude, wind, terrain, and obstructions.	121
377		6. Prepares for landing, or go-around, as specified by the examiner.	304, 309
378		7. Follows the appropriate checklist.	121

		! B. Systems and Equipment Malfunctions	
379		1. Exhibits knowledge of the elements related to system and equipment malfunctions appropriate to the airplane provided for the practical test.	178
380		2. Analyzes the situation and takes appropriate action for simulated emergencies appropriate to the airplane provided for the practical test for at least three (3) of the following—	147, 150, 141
381		a. partial or complete power loss.	Not specifically covered, but included in req. 380
382		b. engine roughness or overheat.	
383		c. carburetor or induction icing.	
384		d. loss of oil pressure.	
385		e. fuel starvation.	
386		f. electrical malfunction.	
387		g. vacuum/pressure, and associated flight instruments malfunction.	
388		h. pitot/static.	
389		i. landing gear or flap malfunction.	
390		j. inoperative trim.	
391		k. inadvertent door or window opening.	
392		l. structural icing.	
393		m. smoke/fire/engine compartment fire.	
394		n. any other emergency appropriate to the airplane.	
395		3. Follows the appropriate checklist or procedure.	
		! C. Emergency Equipment and Survival Gear	
396		Exhibits knowledge of the elements related to emergency equipment and survival gear appropriate to the airplane and environment encountered during flight. Identifies appropriate equipment that should be aboard the airplane.	NC
		XI. NIGHT OPERATION	
		! Night Preparation	
397		1. Physiological aspects of night flying as it relates to vision.	NC
398		2. Lighting systems identifying airports, runways, taxiways and obstructions, and pilot controlled lighting.	101
399		3. Airplane lighting systems.	129
400		4. Personal equipment essential for night flight.	NC
401		5. Night orientation, navigation, and chart reading techniques.	NC
402		6. Safety precautions and emergencies unique to night flying.	NC
		XII. POSTFLIGHT PROCEDURES	
		! A. After Landing, Parking, and Securing	
403		1. Exhibits knowledge of the elements related to after landing, parking and securing procedures.	322, 323, 325, 326, 329, 330, 334, 335, 336

404		2. Maintains directional control after touchdown while decelerating to an appropriate speed.	322, 323, 325
405		3. Observes runway hold lines and other surface control markings and lighting.	322, 323, 325, 330
406		4. Parks in an appropriate area, considering the safety of nearby persons and property.	323, 325, 330, 332, 333, 336
407		5. Follows the appropriate procedure for engine shutdown.	326, 335
408		6. Completes the appropriate checklist.	324
409		7. Conducts an appropriate postflight inspection and secures the aircraft.	334, 336
		X. EMERGENCY OPERATIONS (AMEL)	
		! A. Emergency Descent (AMEL)	
410		1. Exhibits knowledge of the elements related to an emergency descent.	
411		2. Recognizes situations, such as depressurization, cockpit smoke and/or fire that require an emergency descent.	
412		3. Establishes the appropriate airspeed and configuration for the emergency descent.	
413		4. Exhibits orientation, division of attention, and proper planning.	
414		5. Maintains positive load factors during the descent.	
415		6. Completes appropriate checklists.	
		! B. Engine Failure During Takeoff Before VMC (Simulated) (AMEL)	
416		1. Exhibits knowledge of the elements related to the procedure used for engine failure during takeoff prior to reaching VMC.	
417		2. Closes the throttles smoothly and promptly when simulated engine failure occurs.	
418		3. Maintains directional control and applies brakes (AMEL) or flight controls (AMES), as necessary.	
		! C. Engine Failure After Lift-Off (Simulated) (AMEL)	
419		1. Exhibits knowledge of the elements related to the procedure used for engine failure after lift-off.	
420		2. Recognizes a simulated engine failure promptly, maintains control, and utilizes appropriate emergency procedures.	
421		3. Reduces drag, identifies and verifies the inoperative engine after simulated engine failure.	
422		4. Simulates feathering the propeller on the inoperative engine. Examiner shall then establish zero-thrust on the inoperative engine.	
423		5. Establishes VYSE; If obstructions are present, establishes VXSE or VMC +5 knots, whichever is greater, until obstructions are cleared. Then transitions to VYSE.	
424		6. Banks toward the operating engine as required for best performance.	

7. Monitors operating engine and makes adjustments as necessary.

8. Recognizes the airplane's performance capabilities. If a climb is not possible at VYSE, maintain VYSE and return to the departure airport for landing, or initiates an approach to the most suitable landing area available.

9. Secures the (simulated) inoperative engine.

10. Maintains heading, ±10°, and airspeed, ±5 knots.

11. Completes appropriate emergency checklist.

! D. Approach and Landing with an Inoperative Engine (Simulated) (AMEL)

1. Exhibits knowledge of the elements related to an approach and landing with an engine inoperative to include engine failure on final approach.

2. Recognizes engine failure and takes appropriate action, maintains control, and utilizes recommended emergency procedures.

3. Banks toward the operating engine, as required, for best performance.

4. Monitors the operating engine and makes adjustments as necessary.

5. Maintains the recommended approach airspeed +10/–5, and landing configuration with a stabilized approach, until landing is assured.

6. Makes smooth, timely and correct control applications during roundout and touchdown.

7. Touches down on the first one-third of available runway, with no drift and the airplane’s longitudinal axis aligned with and over the runway center/landing path.

8. Maintains crosswind correction and directional control throughout the approach and landing sequence.

9. Completes appropriate checklists.

! E. Systems and Equipment Malfunctions (AMEL)

1. Exhibits knowledge of the elements related to system and equipment malfunctions appropriate to the airplane provided for the practical test.

2. Analyzes the situation and takes the appropriate action for simulated emergencies appropriate to the airplane provided for the practical test for at least three (3) of the following:

a. partial or complete power loss.

b. engine roughness or overheat.

c. carburetor or induction icing.

d. loss of oil pressure.

e. fuel starvation.

f. electrical malfunction.

447 g. vacuum/pressure, and associated flight instruments malfunction.
448 h. pitot/static.
449 i. landing gear or flap malfunction.
450 j. inoperative trim.
451 k. inadvertent door or window opening.
452 l. structural icing.
453 m. smoke/fire/engine compartment fire.
454 n. any other emergency appropriate to the airplane.
455 3. Follows the appropriate checklist or procedure.

! F. Emergency Equipment and Survival Gear (AMEL)

456 Exhibits knowledge of the elements related to emergency equipment and survival gear appropriate to the airplane and environment encountered during flight. Identifies appropriate equipment that should be aboard the airplane.

XI. MULTIENGINE OPERATIONS

Multiengine Operations will not be specifically addressed

! A. Maneuvering with One Engine Inoperative (AMEL)

457 1. Exhibits knowledge of the elements related to maneuvering with one engine inoperative.

458 2. Recognizes engine failure and maintains control.
459 3. Sets the engine controls, reduces drag, identifies and verifies the inoperative engine, and feathers appropriate propeller.
460 4. Establishes and maintains a bank toward the operating engine as required for best performance in straight and level flight.
461 5. Follows the prescribed checklists to verify procedures for securing the inoperative engine.
462 6. Monitors the operating engine and makes necessary adjustments.
463 7. Demonstrates coordinated flight with one engine inoperative (propeller feathered).
464 8. Restarts the inoperative engine using appropriate restart procedures.
465 9. Maintains altitude ±100 feet (30 meters) or minimum sink as appropriate and heading ±10°.
466 10. Completes the appropriate checklists.

! B. VMC Demonstration (AMEL)

467 1. Exhibits knowledge of the elements related to VMC by explaining the causes of loss of directional controls at airspeeds less than VMC, the factors affecting VMC and the safe recovery procedures.

468 2. Configures the airplane at VSSE/VYSE, as appropriate—
469 a. Landing gear retracted.
470 b. Flaps set for takeoff.
471 c. Cowl flaps set for takeoff.

d. Trim set for takeoff.
e. Propellers set for high RPM.
f. Power on critical engine reduced to idle.
g. Power on operating engine set to takeoff or maximum available power.

3. Establishes a single-engine climb attitude with the airspeed at approximately 10 knots above VSSE.

4. Establishes a bank toward the operating engine, as required for best performance and controllability.

5. Increases the pitch attitude slowly to reduce the airspeed at approximately 1 knot per second while applying rudder pressure to maintain directional control until full rudder is applied.

6. Recognizes indications of loss of directional control, stall warning or buffet.

7. Recovers promptly by simultaneously reducing power sufficiently on the operating engine while decreasing the angle of attack as necessary to regain airspeed and directional control. Recovery SHOULD NOT be attempted by increasing the power on the simulated failed engine.

8. Recovers within 20° of the entry heading.

9. Advances power smoothly on operating engine and accelerates to VXSE/VYSE, as appropriate, +10/–5 knots, during the recovery.

! C. Engine Failure During Flight (by Reference to Instruments) (AMEL)

1. Exhibits knowledge of the elements by explaining the procedures used during instrument flight with one engine inoperative.

2. Recognizes engine failure, sets the engine controls, reduces drag, identifies, and verifies the inoperative engine and feathers appropriate engine propeller.

3. Establishes and maintains a bank toward the operating engine as required for best performance in straight and level.

4. Follows the prescribed checklists to verify procedures for securing the inoperative engine.

5. Monitors the operating engine and makes necessary adjustments.

6. Demonstrates coordinated flight with one engine inoperative.

7. Maintains altitude ±100 feet (30 meters), or minimum sink as appropriate and heading ±10°, bank ±5°, and levels off from climbs and descents within ± 100 feet (30 meters).

! D. Instrument Approach—One Engine Inoperative (by Reference to Instruments) (AMEL)

1. Exhibits knowledge of the elements by explaining the procedures used during a published instrument approach with one engine inoperative.

491 2. Recognizes engine failure, sets the engine controls, reduces drag, identifies and verifies the inoperative engine, and feathers appropriate engine propeller.

492 3. Establishes and maintains a bank toward the operating engine, as required, for best performance in straight and level flight.

493 4. Follows the prescribed checklists to verify procedures for securing the inoperative engine.

494 5. Monitors the operating engine and makes necessary adjustments.

495 6. Requests and receives an actual or a simulated ATC clearance for an instrument approach.

496 7. Follows the actual or a simulated ATC clearance for an instrument approach.

497 8. Maintains altitude within 100 feet (30 meters), the airspeed within ±10 knots if within the aircraft's capability, and heading ±10.

498 9. Establishes a rate of descent that will ensure arrival at the MDA or DH/DA, with the airplane in a position from which a descent to a landing, on the intended runway can be made, either straight in or circling as appropriate.

499 10. On final approach segment, no more than three-quarter-scale deflection of the CDI/glide slope indicator. For RMI or ADF indicators, within 10° of the course.

500 11. Avoids loss of aircraft control, or attempted flight contrary to the engine-inoperative operating limitations of the aircraft.

501 12. Complies with the published criteria for the aircraft approach category when circling.

502 13. Completes landing and appropriate checklists.

Practical Test Standards - Instrument Rating

I. PREFLIGHT PREPARATION

A. Weather Information

503	1. Exhibits adequate knowledge of the elements related to aviation weather information by obtaining, reading, and analyzing the applicable items, such as—	182, 185, 193, 197, 198
504	a. weather reports and forecasts.	251, 253, 292, 31
505	b. pilot and radar reports.	31
506	c. surface analysis charts.	31
507	d. radar summary charts.	31
508	e. significant weather prognostics.	33
509	f. winds and temperatures aloft.	195, 31
510	g. freezing level charts.	
511	h. stability charts.	31

512		i. severe weather outlook charts.	31
513		j. SIGMETs and AIRMETs.	
514		k. ATIS reports.	
515		2. Correctly analyzes the assembled weather information pertaining to the proposed route of flight and destination airport, and determines whether an alternate airport is required, and, if required, whether the selected alternate airport meets the regulatory requirement.	182, 185, 193, 194, 197, 198
		B. Cross-Country Flight Planning	
516		1. Exhibits adequate knowledge of the elements by presenting and explaining a preplanned cross-country flight, as previously assigned by the examiner (preplanning is at examiner's discretion). It should be planned using real time weather and conform to the regulatory requirements for instrument flight rules within the airspace in which the flight will be conducted.	182
517		2. Exhibits adequate knowledge of the aircraft's performance capabilities by calculating the estimated time en route and total fuel requirement based upon factors, such as—	193, 198
518		a. power settings.	193, 198
519		b. operating altitude or flight level.	193, 198
520		c. wind.	182, 193, 198
521		d. fuel reserve requirements.	128, 193, 198
522		3. Selects and correctly interprets the current and applicable en route charts, instrument departure procedures (DPs), RNAV, STAR, and Standard Instrument Approach Procedure Charts (IAP).	26, 19
523		4. Obtains and correctly interprets applicable NOTAM information.	60, 53, 20
524		5. Determines the calculated performance is within the aircraft's capability and operating limitations.	128
525		6. Completes and files a flight plan in a manner that accurately reflects the conditions of the proposed flight. (Does not have to be filed with ATC.)	29, 56
526		7. Demonstrates adequate knowledge of GPS and RAIM capability, when aircraft is so equipped.	22
		II. PREFLIGHT PROCEDURES	
		A. Aircraft Systems Related to IFR Operations	

527		Exhibits adequate knowledge of the elements related to applicable aircraft anti-icing/deicing system(s) and their operating methods to include:	130
528		1. Airframe.	130
529		2. Propeller.	130
530		3. Intake.	130
531		4. Fuel.	130
532		5. Pitot-static.	130
		B. Aircraft Flight Instruments and Navigation Equipment	
533		1. Exhibits adequate knowledge of the elements related to applicable aircraft flight instrument system(s) and their operating characteristics to include—	129, 130, 184
534		a. pitot-static.	129, 130, 184
535		b. altimeter.	129, 130, 184
536		c. airspeed indicator.	129, 130, 184
537		d. vertical speed indicator.	129, 130, 184
538		e. attitude indicator.	129, 130, 184
539		f. horizontal situation indicator.	129, 130, 184
540		g. magnetic compass.	129, 130, 184
541		h. turn-and-slip indicator/turn coordinator.	129, 130, 184
542		i. heading indicator.	129, 130, 184
543		j. electrical systems.	129, 130, 184
544		k. vacuum systems.	129, 130, 184
545		l. electronic flight instrument display.	129, 130, 184
546		2. Exhibits adequate knowledge of the applicable aircraft navigation system(s) and their operating characteristics to include—	129, 130, 184
547		a. VOR.	129, 130, 184
548		b. DME.	129, 130, 184
549		c. ILS.	129, 130, 184
550		d. marker beacon receiver/indicators.	129, 130, 184
551		e. transponder/altitude encoding.	129, 130, 184
552		f. ADF.	129, 130, 184
553		g. GPS.	129, 130, 184
554		h. FMS.	129, 130, 184
		C. Instrument Cockpit Check	
555		1. Exhibits adequate knowledge of the elements related to preflighting instruments, avionics, and navigation equipment cockpit check by explaining the reasons for the check and how to detect possible defects.	130, 129

556		2. Performs the preflight on instruments, avionics, and navigation equipment cockpit check by following the checklist appropriate to the aircraft flown.	130, 129
557		3. Determines that the aircraft is in condition for safe instrument flight including—	130, 129
558		a. communications equipment.	130, 129
559		b. navigation equipment, as appropriate to the aircraft flown.	130, 129
560		c. magnetic compass.	130, 129
561		d. heading indicator.	130, 129
562		e. attitude indicator.	130, 129
563		f. altimeter.	130, 129
564		g. turn-and-slip indicator/turn coordinator.	130, 129
565		h. vertical speed indicator.	130, 129
566		i. airspeed indicator.	130, 129
567		j. clock.	130, 129
568		k. power source for gyro-instruments.	130, 129
569		l. pitot heat.	130, 129
570		m. electronic flight instrument display	130, 129
571		n. traffic awareness/warning/avoidance system.	130, 129
572		o. terrain awareness/warning/alert system.	130, 129
573		p. FMS.	130, 129
574		q. auto pilot.	130, 129
575		4. Notes any discrepancies and determines whether the aircraft is safe for instrument flight or requires maintenance.	130, 129
		III. AIR TRAFFIC CONTROL CLEARANCES AND PROCEDURES	
		A. Air Traffic Control Clearances	
576		1. Exhibits adequate knowledge of the elements related to ATC clearances and pilot/controller responsibilities to include tower en route control and clearance void times.	137, 187, 188, 189
577		2. Copies correctly, in a timely manner, the ATC clearance as issued.	137, 189, 190
578		3. Determines that it is possible to comply with ATC clearance.	137
579		4. Interprets correctly the ATC clearance received and, when necessary, requests clarification, verification, or change.	137
580		5. Reads back correctly, in a timely manner, the ATC clearance in the sequence received.	137, 189, 190
581		6. Uses standard phraseology when reading back clearance.	137, 190
582		7. Sets the appropriate communication and navigation systems and transponder codes in compliance with the ATC	137, 188, 192

			clearance.	
			B. Compliance with Departure, En Route, and Arrival Procedures and Clearances	
583			1. Exhibits adequate knowledge of the elements related to ATS routes, and related pilot/controller responsibilities.	193, 202
584			2. Uses the current and appropriate navigation publications for the proposed flight.	26
585			3. Selects and uses the appropriate communication facilities; selects and identifies the navigation aids associated with the proposed flight.	189, 26
586			4. Performs the appropriate aircraft checklist items relative to the phase of flight.	140, 177
587			5. Establishes two-way communications with the proper controlling agency, using proper phraseology.	137, 187, 189, 190
588			6. Complies, in a timely manner, with all ATC instructions and airspace restrictions.	137, 188
589			7. Exhibits adequate knowledge of communication failure procedures.	178
590			8. Intercepts, in a timely manner, all courses, radials, and bearings appropriate to the procedure, route, or clearance.	200
591			9. Maintains the applicable airspeed within +/-10 knots; headings within +/-10°; altitude within +/-100 feet; and tracks a course, radial or bearing within ¾ scale deflection of the CDI.	144
			C. Holding Procedures	
592			1. Exhibits adequate knowledge of the elements related to holding procedures.	257
593			2. Changes to the holding airspeed appropriate for the altitude or aircraft when 3 minutes or less from, but prior to arriving at, the holding fix.	264
594			3. Explains and uses an entry procedure that ensures the aircraft remains within the holding pattern airspace for a standard, nonstandard, published, or nonpublished holding pattern.	262
595			4. Recognizes arrival at the holding fix and initiates prompt entry into the holding pattern.	262
596			5. Complies with ATC reporting requirements.	137, 188, 189
597			6. Uses the proper timing criteria, where applicable, as required by altitude or ATC instructions.	137
598			7. Complies with pattern leg lengths when a DME distance is specified.	264

599			8. Uses proper wind correction procedures to maintain the desired pattern and to arrive over the fix as close as possible to a specified time.	193
600			9. Maintains the airspeed within +/-10 knots; altitude within +/- 100 feet; headings within +/-10°; and tracks a selected course, radial or bearing within ¾ scale deflection of the CDI.	144
			IV. FLIGHT BY REFERENCE TO INSTRUMENTS	
			A. Basic Instrument Flight Maneuvers	
601			1. Exhibits adequate knowledge of the elements related to attitude instrument flying during straight-and-level, climbs, turns, and descents while conducting various instrument flight procedures.	133
602			2. Maintains altitude within +/- 100 feet during level flight, headings within +/- 10°, airspeed within +/- 10 knots, and bank angles within +/- 5° during turns.	144
603			3. Uses proper instrument crosscheck and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.	145, 146, 181
			B. Recovery from Unusual Flight Attitudes	
604			1. Exhibits adequate knowledge of the elements relating to attitude instrument flying during recovery from unusual flight attitudes (both nose-high and nose-low).	134, 135, 136, 150, 178, 179, 180, 184
605			2. Uses proper instrument cross-check and interpretation, and applies the appropriate pitch, bank, and power corrections in the correct sequence to return the aircraft to a stabilized level flight attitude.	134, 135, 136, 150, 177, 181, 184
			V. NAVIGATION SYSTEMS	
			A. Intercepting and Tracking Navigational Systems and DME Arcs	
606			1. Exhibits adequate knowledge of the elements related to intercepting and tracking navigational systems and DME arcs.	NC
607			2. Tunes and correctly identifies the navigation facility.	NC
608			3. Sets and correctly orients the course to be intercepted into the course selector or correctly identifies the course on the RMI.	184
609			4. Intercepts the specified course at a predetermined angle, inbound or outbound from a navigational facility.	NC
610			5. Maintains the airspeed within +/-10 knots, altitude within +/- 100 feet, and selected headings within +/-5°.	144

611	6. Applies proper correction to maintain a course, allowing no more than three-quarter-scale deflection of the CDI or within +/-10° in case of an RMI.		NC
612	7. Determines the aircraft position relative to the navigational facility or from a waypoint in the case of GPS.	200	
613	8. Intercepts a DME arc and maintain that arc within +/-1 nautical mile.		NC
614	9. Recognizes navigational receiver or facility failure, and when required, reports the failure to ATC.	178	
	VI. INSTRUMENT APPROACH PROCEDURES		
	A. Nonprecision Approach (NPA)		
615	NOTE: The applicant must accomplish at least two nonprecision approaches (one of which must include a procedure turn or, in the case of an RNAV approach, a Terminal Arrival Area (TAA) procedure) in simulated or actual weather conditions. At least one nonprecision approach must be flown without the use of autopilot and without the assistance of radar vectors.		NC
616	1. Exhibits adequate knowledge of the elements related to an instrument approach procedure.	272	
617	2. Selects and complies with the appropriate instrument approach procedure to be performed.	279	
618	3. Establishes two-way communications with ATC, as appropriate, to the phase of flight or approach segment, and uses proper communication phraseology and technique.	273, 139, 189, 190, 191	
619	4. Selects, tunes, identifies, and confirms the operational status of navigation equipment to be used for the approach procedure.	275, 183	
620	5. Complies with all clearances issued by ATC or the examiner.	188	
621	6. Recognizes if any flight instrumentation is inaccurate or inoperative, and takes appropriate action.	282, 178	
622	7. Advises ATC or examiner anytime that the aircraft is unable to comply with a clearance.	189, 190	
623	8. Establishes the appropriate aircraft configuration and airspeed considering turbulence and wind shear, and completes the aircraft checklist items appropriate to the phase of the flight.	140, 181, 195, 198	
624	9. Maintains, prior to beginning the final approach segment, altitude within +/-100 feet, heading within +/-10° and allows less than ¾ scale deflection of the CDI or within +/-10° in the case of an RMI, and maintains airspeed within +/-10 knots.		NC

625		10. Applies the necessary adjustments to the published MDA and visibility criteria for the aircraft approach category when required, such as—	291, 296
626		a. NOTAMs.	291, 296
627		b. inoperative aircraft and ground navigation equipment.	291, 296
628		c. inoperative visual aids associated with the landing environment.	291, 296
629		d. NWS reporting factors and criteria.	291, 296
630		11. Establishes a rate of descent and track that will ensure arrival at the MDA prior to reaching the MAP with the aircraft continuously in a position from which descent to a landing on the intended runway can be made at a normal rate using normal maneuvers.	279
631		12. Allows, while on the final approach segment, no more than a three-quarter-scale deflection of the CDI or within 10° in case of an RMI, and maintains airspeed within +/-10 knots of that desired.	NC
632		13. Maintains the MDA, when reached, within +100 feet, -0 feet to the MAP.	279
633		14. Executes the missed approach procedure when the required visual references for the intended runway are not distinctly visible and identifiable at the MAP.	304, 308, 309, 310
634		15. Executes a normal landing from a straight-in or circling approach when instructed by the examiner.	312?, 313?, 314, 316, 317, 318, 319?, 320, 321?, 183
		B. Precision Approach (PA)	
635		NOTE: A precision approach, utilizing aircraft NAVAID equipment	279
636		for centerline and vertical guidance, must be accomplished in	279
637		simulated or actual instrument conditions to DA/DH.	279
638		1. Exhibits adequate knowledge of the precision instrument approach procedures.	272, 184
639		2. Accomplishes the appropriate precision instrument approaches as selected by the examiner.	183, 279
640		3. Establishes two-way communications with ATC using the proper communications phraseology and techniques, as required for the phase of flight or approach segment.	273, 137, 188, 189, 190
641		4. Complies, in a timely manner, with all clearances, instructions, and procedures.	
642		6. Establishes the appropriate airplane configuration and airspeed/V-speed considering turbulence, wind shear, microburst conditions, or other meteorological and operating	195, 198

		conditions.	
643		7. Completes the aircraft checklist items appropriate to the phase of flight or approach segment, including engine out approach and landing checklists, if appropriate.	140
644		8. Prior to beginning the final approach segment, maintains the desired altitude +/-100 feet, the desired airspeed within +/-10 knots, the desired heading within +/-10°; and accurately tracks radials, courses, and bearings.	144, 279
645		9. Selects, tunes, identifies, and monitors the operational status of ground and airplane navigation equipment used for the approach.	275, 177
646		10. Applies the necessary adjustments to the published DA/DH and visibility criteria for the airplane approach category as required, such as—	276
647		a. NOTAMs	276
648		c. inoperative visual aids associated with the landing environment.	276
649		d. NWS reporting factors and criteria.	276
650		11. Establishes a predetermined rate of descent at the point where the electronic glide slope begins, which approximates that required for the aircraft to follow the glide slope.	279
651		12. Maintains a stabilized final approach, from the Final Approach Fix to DA/DH allowing no more than threequarter scale deflection of either the glide slope or localizer indications and maintains the desired airspeed within +/-10 knots.	NC
652		13. A missed approach or transition to a landing shall be initiated at Decision Height.	304
653		14. Initiates immediately the missed approach when at the DA/DH, and the required visual references for the runway are not unmistakably visible and identifiable.	277
654		15. Transitions to a normal landing approach (missed approach for seaplanes) only when the aircraft is in a position from which a descent to a landing on the runway can be made at a normal rate of descent using normal maneuvering.	279
655		16. Maintains localizer and glide slope within three-quarterscale deflection of the indicators during the visual descent from DA/DH to a point over the runway where glide slope must be abandoned to accomplish a normal landing.	NC

C. Missed Approach

656		1. Exhibits adequate knowledge of the elements related to missed approach procedures associated with standard instrument approaches.	179, 201, 202, 277, 304
657		2. Initiates the missed approach promptly by applying power, establishing a climb attitude, and reducing drag in accordance with the aircraft manufacturer's recommendations.	201, 202, 304, 308, 309, 310
658		3. Reports to ATC beginning the missed approach procedure.	189, 190, 202
659		4. Complies with the published or alternate missed approach procedure.	308, 310
660		5. Advises ATC or examiner anytime that the aircraft is unable to comply with a clearance, restriction, or climb gradient.	189
661		6. Follows the recommended checklist items appropriate to the go-around procedure.	140, 283, 311
662		7. Requests, if appropriate, ATC clearance to the alternate airport, clearance limit, or as directed by the examiner.	189, 190
663		8. Maintains the recommended airspeed within +/-10 knots; heading, course, or bearing within +/-10°; and altitude(s) within +/-100 feet during the missed approach procedure.	310
		D. Circling Approach	
664		1. Exhibits adequate knowledge of the elements related to a circling approach procedure.	272
665		2. Selects and complies with the appropriate circling approach procedure considering turbulence and wind shear and considering the maneuvering capabilities of the aircraft.	279
666		3. Confirms the direction of traffic and adheres to all restrictions and instructions issued by ATC and the examiner.	279
667		4. Does not exceed the visibility criteria or descend below the appropriate circling altitude until in a position from which a descent to a normal landing can be made.	296
668		5. Maneuvers the aircraft, after reaching the authorized MDA and maintains that altitude within +100 feet, -0 feet and a flight path that permits a normal landing on a runway. The runway selected must be such that it requires at least a 90° change of direction, from the final approach course, to align the aircraft for landing.	279
669		**E. Landing from a Straight-in or Circling Approach**	
670		1. Exhibits adequate knowledge of the elements related to the pilot's responsibilities, and the environmental, operational, and meteorological factors, which affect a landing from a straight-in or a circling, approach.	272

671		2. Transitions at the DA/DH, MDA, or VDP to a visual flight condition, allowing for safe visual maneuvering and a normal landing.	296
672		3. Adheres to all ATC (or examiner) advisories, such as NOTAMs, wind shear, wake turbulence, runway surface, braking conditions, and other operational considerations.	293
673		4. Completes appropriate checklist items for the pre-landing and landing phase.	140
674		5. Maintains positive aircraft control throughout the complete landing maneuver.	183, 314
		VII. EMERGENCY OPERATIONS	
		A. Loss of Communications	
675		1. Recognizing loss of communication.	131, 137, 139, 142, 191, 192
676		2. Continuing to destination according to the flight plan.	183
677		3. When to deviate from the flight plan.	182, 200
678		4. Timing for beginning an approach at destination.	203
		B. One Engine Inoperative During Straight-and-Level Flight and Turns (Multiengine Airplane)	
679		1. Exhibits adequate knowledge of the procedures used if engine failure occurs during straight-and-level flight and turns while on instruments.	139, 140, 147, 178, 184
680		2. Recognizes engine failure simulated by the examiner during straight-and-level flight and turns.	
681		3. Sets all engine controls, reduces drag, and identifies and verifies the inoperative engine.	
682		4. Establishes the best engine-inoperative airspeed and trims the aircraft.	
683		5. Verifies the accomplishment of prescribed checklist procedures for securing the inoperative engine.	140
684		6. Establishes and maintains the recommended flight attitude, as necessary, for best performance during straight-and-level and turning flight.	133, 183
685		7. Attempts to determine the reason for the engine failure.	178
686		8. Monitors all engine control functions and makes necessary adjustments.	177
687		9. Maintains the specified altitude within +/-100 feet, (if within the aircraft's capability), airspeed within +/-10 knots, and the specified heading within +/-10°.	
688		10. Assesses the aircraft's performance capability and decides an appropriate action to ensure a safe landing.	183
689		11. Avoids loss of aircraft control, or attempted flight contrary to the engine-inoperative operating limitations of the aircraft.	128

C. One Engine Inoperative—Instrument Approach (Multiengine Airplane)

690 1. Exhibits adequate knowledge of the elements by explaining the procedures used during an instrument approach in a multiengine aircraft with one engine inoperative.

691 2. Recognizes promptly, engine failure simulated by the examiner.

692 3. Sets all engine controls, reduces drag, and identifies and verifies the inoperative engine.

693 4. Establishes the best engine-inoperative airspeed and trims the aircraft.

694 5. Verifies the accomplishment of prescribed checklist procedures for securing the inoperative engine. 140, 194

695 6. Establishes and maintains the recommended flight attitude and configuration for the best performance for all maneuvering necessary for the instrument approach procedures. 183

696 7. Attempts to determine the reason for the engine failure. 178

697 8. Monitors all engine control functions and makes necessary adjustments.

698 9. Requests and receives an actual or a simulated ATC clearance for an instrument approach. 137, 189

699 10. Follows the actual or a simulated ATC clearance for an instrument approach.

700 11. Establishes a rate of descent that will ensure arrival at the MDA/DH prior to reaching the MAP with the aircraft continuously in a position from which descent to a landing on the intended runway can be made straight-in or circling.

701 12. Maintains, where applicable, the specified altitude within +/-100 feet, the airspeed within +/-10 knots if within the aircraft's capability, and the heading within +/-10°.

702 13. Sets the navigation and communication equipment used during the approach and uses the proper communications technique. 188, 192, 273, 275

703 14. Avoids loss of aircraft control, or attempted flight contrary to the engine-inoperative operating limitations of the aircraft. 128

704 15. Complies with the published criteria for the aircraft approach category when circling.

705 16. Allows, while on final approach segment, no more than three-quarter-scale deflection of either the localizer or glide slope or GPS indications, or within +/-10° or ¾ scale deflection of the nonprecision final approach course.

706 17. Completes a safe landing. 183

			D. Loss of Primary Flight Instrument Indicators	
707			1. Exhibits adequate knowledge of the elements relating to recognizing if primary flight instruments are inaccurate or inoperative, and advise ATC or the examiner.	137, 178, 189
708			2. Advises ATC or examiner anytime that the aircraft is unable to comply with a clearance.	137, 189
709			3. Demonstrates a nonprecision instrument approach without the use of the primary flight instrument using the objectives of the nonprecision approach TASK (AREA OF OPERATION VI, TASK A).	NC
			VIII. POSTFLIGHT PROCEDURES	
			A. Checking Instruments and Equipment	
710			1. Exhibits adequate knowledge of the elements relating to all instrument and navigation equipment for proper operation.	177, 326?
711			2. Notes all flight equipment for proper operation.	130, 177
712			3. Notes all equipment and/or aircraft malfunctions and makes appropriate documentation of improper operation or failure of such equipment.	130, 177

Access 5 Project Office
NASA
P.O. Box 273
Edwards, CA 93523 USA
661-276-2440
661-276-3880 FAX
www.access5.aero

Appendix B – HALE UAS KSAs

HALE UAS Pilot KSA

	Phase of Operation and Knowledge, Skill, or Ability	Corresponding Part 61 section or PTS knowledge/skill
	PREFLIGHT	89
1	UA pilot privileges/ limitations and recent flight experience requirements	33, 90
2	Medical certificate class and duration	91, covered under FAR 61.23
3	Procedures for completing Pilot logbook/Flight Records	94, covered under FAR 61.51
4	Operating Limitations, placards, instrument markings and POH/AFM	10, 40, 94
5	Knowledge of FARs/ACs	4, 5, 7, 34, 36
6	Reading, writing, interpreting FAR's,	4,34,36
7	Math skills to Support Mission Planning	15,43,51, 119, 122
8	Required instruments and systems for day/night/IFR conditions and icing	6,36, 97, 98
9	Procedures and limitations for determining UA airworthiness with inoperative instruments and equipment with and without a MEL	6,36, 98, 119 (?)
10	Determine mission accomplishment vs. Minimum time airborne vs. minimum fuel consumed	15,47,51, 114, 119
11	Ability to speak, write and understand English	32, 114 (?)
12	Capabilities at selected destination to support the UA	47, 53, 121, 185 (?), 186 (?)
13	Operations at selected airport to support UA	47 (similar to KSA #12), 53, 121, 185, 186
14	Location of control stations at destination airport and proposed alternate sites	not directly covered, 53, 121, 185, 186
15	LOS and BLOS data link coverage capabilities	179 (?) not directly covered, 94, 126, 137
16	Determine if the UA can operate within the confines of the destination airport.	47, 113 (?), 53, 121, 185, 186
17	Ability to plan, analyze and decide on the appropriateness of selected destination or alternates	47 (similar to KSA #16), 114-122, 126-129
18	UA Navigation Equipment capabilities and limitations	7,19, 115, 94, 126, 137
19	Aeronautical Charts	8,37, 125, 522
20	Flight Information files, NOTAMs, etc.	5,36, 121, 523
21	IFR rules/requirements	4, 10, 120
22	Enroute Navigation Aids	6, 7,19
23	Pilotage and Dead Reckoning techniques	6, 37,57,59, 116, 117 (?) , 297
24	Minimum Safe Altitudes for crossing various types of terrain	8,10, 522, 524
25	LOS and BLOS Data Link Capabilities/Coverage	not directly covered, 94, 126, 137
26	Select and correctly interpret applicable en-route charts, instrument departure procedures, RNAV, STAR, and Standard Instrument Approach procedures	7, 8,20, 121, 522
27	Correctly interpret NOTAM information	5,15,36,46, 121, 523
28	Determine if the calculated performance is within the UAs capability and operating limitations	10,40,41,47, 126-129
29	Ability to Plan	12, 15,46

30		Understand and Plan for appropriate LOS and BLOS data link coverage	105, 106, 107, 108, 15 (not clear and may applicable), 126, 128,129, 137
31		Weather information sources and the impact of weather on aircraft, and system performance (e.g., METAR, TAF, Surface Analysis Charts, and Radar Summary Charts, Winds and Temperature Aloft, Convective, Weather Outlook Charts, etc.).	105-114, 118, 9,11,39 (lots of variations o weather issues KSAs), 126, 128, 129
32		Weather Avoidance Criteria	9,11, 12 ,39, 109, 114
33		Wind Directions and Speeds at Different Altitudes/Locations along the proposed flight route	9,11,39, 109, 140 (?)
34		Freezing levels, and Frost and Ice Removal/Avoidance Procedures	9,10,11,16,39,40, 85
35		Make competent go/no-go decision based on available information	105, 113, 114 (?), 129 (?), 12,45 (KSA ite thru 40 all similar)
36		Plan flight taking into consideration where and when weather may occur	9, 11, 12, 15, 105
37		Proceed to alternate and reassess destination weather	9, 10,11,12,40,45,48, 105
38		Interpret special weather conditions for FL 430	9, 11, 39, 105
39		Reschedule mission based on long duration weather obstacles	12,45, 105-113, 85
40		Ability to put together a comprehensive picture of the Weather and to forecast the impact of weather along the planned flight route and to determine whether a flight plan change is necessary	9,15, 105-113, 126, 128 (?)
41		UA flight performance capabilities (e.g., Climb, speed, aircraft endurance, fuel burn rates, etc.)	10,40, 126, 128, 129
42		Mission requirements (desired arrival time at destination, etc.)	15, 126, 128, 129
43		Inflight Maneuver Limitations	10,40, 126, 128, 129
44		Select altitude as determined by mission requirement, or minimum terrain avoidance, or max performance cruise (max range, max endurance, etc.) for minimum fuel used.	10,40, 118, 119
45		Capabilities at alternate destination to support the UA.	10,40,47, 48, 185, 186
46		Factors to consider when selecting an alternate landing site	10,40,47, 48, 57, 60,185,186
47		Runway length/width & other factors that impact UA operations	10,40,47, 126-129
48		Lost Link procedures	not directly covered, 60, 136, 137
49		Ability to plan, analyze & decide on an appropriateness of alternate destinations	12,45, 40, 45, 47, 48, 185, 186
50		International arena consider political climate in selecting destinations and alternates.	15,51 (political/international issues? This stretch), 1D, 48,114-122
51		Elements related to cross-country flight planning	15,51, 114-122
52		Use of appropriate and current aeronautical charts	8,15,37
53		Application of pertinent information from NOTAMs, A/FD and other flight publications	15,47, 121, 124
54		IFR minimums for all classes of airspace, and operating rules	4, 124, 125
55		Special Use & other Airspace areas	4,34, 125
56		Procedures for Filing an IFR Flight Plan	15, 525
57		Limitations in Communication Links and impact on signal transmission/reception	not directly covered, 545, 546

58		Strong and weak areas for LOS & BLOS comms (e.g., Satellite footprint/availability, etc.)	not directly covered, 533, 546
59		Skill in using flight planning tools	15,51, 127, 516
60		Ability to read, interpret, and use various maps, charts, forms, etc	8,37, 522
61		Skill in map reading	8,37, 522
62		Ability to complete proper form for flight plan to gain access to controlled airspace	15, 516, 522
63		Capability to analyze enroute, arrival and alternative landing site weather conditions & forecasts	9,15,39,47, 515
64		Use mission, navigation & weather data to plan mission	9,15,39,47, 515, 94
65		Application of ALL mission abilities added to analysis of developing weather phenomenon. Systems knowledge in development of aircraft sub systems loss/damage as it applies to risk analysis for mission accomplishment	too broad, don't really know what this is a 515, 94
66		Knowledge of criteria for making a GO/NO-GO Decision	12,45, 105, 113
67		Extensive sensor systems and aircraft systems knowledge. Understand rationale for development of GO/NO-GO criteria.	12,45, 105, 113
68		Crew duty requirements	34, 148 not directly covered
69		Alcohol and drug prohibitions and limitations	34, 150 (?) covered under FAR 61.15, 61. 61.53, FAR 91.17, 91.19
70		Rest requirements	34, 1J (?) not directly covered
71		Ability to self analyze current and future physiological and psychological state to ensure safe operation of the UA	45, covered under FAR 61.53
		GROUND OPERATIONS	
72		Elements related to performance and limitations of aircraft systems and the impact of exceeding specified limitations	nebulous (not supposed to exceed any lin 126 - 129
73		Knowledge of Flight Manual	15,51,94
74		Required instruments and equipment for day/night IFR	4,34, 61, 97, 124
75		Procedures for determining airworthiness of the airplane with inoperative instruments & equipment with and without a MEL	4,34, 98
76		Procedures for determining the Health & Status of the UA and AVCS	10,40, 130-140,159, 161, 168
77		Failure Modes and System Limitations	(not clear, very different topics) 10,40, 12
78		Procedures for Fault Isolation & correction	60 not directly covered
79		Procedures for establishing LOS & BLOS Communication Links and Frequency Management	136, 137, 168 not directly covered
80		Data Link limitations	126, 128, 137 not directly covered, maybe
81		Functioning of the AVCS and the UA for performing the required mission	43 (what??) 10,40
82		Ability to judge whether safe flight can be conducted	12,45, 154, 45
83		Skill in operating aircraft and avionics systems	10,40, 137 (?) 1D (?), 130, 136, 137
84		Ability to take corrective actions	10,40, 130-140, 168
85		Ability to establish & verify a command and control link to the UA	137, 172 (what??) 10,40
86		Engine start procedures & limitations	10,40, 159, 159, 160, 161
87		Indications of normal operations, and procedures for applying power, verifying the status of applicable aircraft	10,40, 130-140,159, 161, 168

		systems. Flight Information, etc.	
88		Use of Appropriate checklist(s)	161, 172 not directly covered
89		Procedures for applying power to required systems	10,40, 136, 159
90		Skill in accomplishing start procedures and use of engine start controls.	10,40, 159-161
91		Communication procedures with ATC	175, 38, 17 (KSA 91 thru 96 all similar)
92		Procedures for using AVCS equipment to communicate with ATC (e.g., selection of radio, appropriate frequency, etc.)	17, 176, 38
93		Communication equipment and procedures	17, 38
94		Appropriate ATC phraseology	17, 177, 38
95		Ability to judge appropriateness of ATC instructions	17, 38, 178 (?), 45
96		Ensure credible, clear instructions	17,32,38
97		Understand English language (ICAO standard)	32
98		Elements related to safe taxi procedures	10, 40, 162 - 167
99		Brake test procedures	10,40,52,53, 163, 77, 130, 134,162
100		Procedures for manipulating flight controls properly for current wind conditions	53,54, 77, 130, 164
101		Procedures for complying with airport/taxiway markings, signals, ATC clearances and instructions	38, 53, 398
102		Procedures for accomplishing ground operations at non-towered airports	36, 52, 53
103		Skill in taxiing aircraft	53, 162-167
104		Skill in monitoring aircraft systems to assess system performance during taxi operations	53, 130-140,162
105		Skill in identifying & avoiding obstacles	53, 167
106		Ability to read and follow airport taxi diagrams	53, 166
107		Knowledge of operating procedures at controlled and uncontrolled airports	36, 53, 179, 180
108		Elements related to before takeoff check, including pre-flighting instruments, avionics, and navigation equipment	16,52, 168-174
109		Procedures for detecting and rectifying malfunctions	126, 128-140, 168, (??) 10,40 maybe
110		Procedures for performing the before takeoff checklist	52, 168
111		Takeoff performance airspeeds, takeoff distances, departure and emergency procedures	47,54,60, 173
112		Procedures for avoiding runway incursions	53, 174
113		Ability to read, understand and perform checklist items.	32,52, 86
114		Skill in locating and using specified controls to obtain the desired outcome	10,40,77
115		Elements related to ATC communications	175-178, 6,38 (KSA 115 thru 118 all simil
116		Procedures for selecting the appropriate communication frequencies	6,38, 175-178
117		ATC communication phraseology/protocols	6,38, 175-178
118		Procedures for acknowledging ATC communications and complying with instructions	6,17,38, 175-178
119		Base, runway, and taxiway operations with emphasis on incursion avoidance	53, 174 (?)
120		Ability to comply with tower instructions	17,38,53, 175-178
121		Skill to adapt to back up plan during emergency airfield operations.	85, 371,373,375, 376, 378, ?? 10,40

122		Knowledge of sensor limits to environmental conditions	126, 129, ?? This could be payload or inh details
123		Knowledge of environmental conditions (hot day)	10,11,40,41,47, 129
124		Power and time limitations	126, 128, ??
125		Read and accomplish checklist items	10,40, 86, 153 (?), 161
126		Ability to configure sensor equipment, if required	137, maybe 10,40 see 122
127		Ability to understand sensor displays and malfunction indications	137, 10,40 again
		ALL FLIGHT PHASES	
128		Aircraft performance requirements and limitations and the impact of exceeding specified limitations	39, 40, 41, 42, 43, 44, 517, 521, 524, 689
129		Required instruments and equipment for day/night IFR	34, 36, 533
130		Procedures for determining airworthiness of the airplane with and without inoperative instruments & equipment, and with and without a MEL	34, 36, 533, 711, 712
131		Data Link limitations	40, 675
132		Spatial disorientation, fatigue & countermeasures to these threats	36, 40, 84
133		Elements related to attitude instrument flying during straight-and-level, climbs turns, and descents while conducting various instrument flight procedures	601, 684
134		Unsafe flight attitudes and recovery procedures	44, 604, 605
135		Stall characteristics and stall recovery procedures	44, 79, 604, 605
136		Causes and prevention of Pilot induced Oscillations	40, 604, 605
137		Communication requirements and procedures with ATC	38, 313, 322, 576-582, 588, 596, 618, 640 708
138		Operations at controlled and uncontrolled airports	36, 38, 40
139		UA and AVCS operations and Emergency Procedures	40, 675, 679, 694
140		Normal and Abnormal Checklist Procedures	40, 586, 623, 643, 661, 673, 679, 683, 69
141		Demonstrate good Aeronautical Decision-Making	45, 85
142		Maintain Situational Awareness	675
143		Ability to visualize - Demonstrate Tactical Planning Skills	
144		Maintain control of the aircraft at all times	53, 54, 55, 56, 58, 59, 60, 61, 77, 78, 79,
145		Instrument scan, crosscheck and interpretation procedures	59, 603
146		Integration of instrument scan with scan of other displays	59, 603
147		Ability to stay ahead of the airplane to enable a rapid response to unplanned mission events & contingencies	60, 679
148		Ability to recognize Spatial Disorientation and causes of PIO	59? 364, 365
149		Ability to compensate for response lags from pilot control input to display feedback	54, 55, 56, 58, 59, 77, 271
150		Ability to apply knowledge of aircraft system operations and emergency procedures to safely & effectively avoid/mitigate against unplanned mission events, contingencies and emergency events	60, 604, 605
		TAKEOFF/CLIMBOUT	
151		Procedures for configuring the aircraft for take-off	10,40,54, 130, 131, 172
152		Knowledge of communication procedures for towered and un-towered airports	6,17,36,38,53, 175, 176, 177, 178

153		Knowledge of Wake Turbulence effects and restrictions	36,40, 81, 179
154		Procedures for accomplishing normal and crosswind takeoffs	54, 187, 188, 189, 190, 192
155		Aircraft takeoff performance characteristics, airspeeds, and adjustments due to atmospheric conditions, emergency procedures, and abnormal performance indications	47,54, 173, 192, 193
156		Right of Way rules, Sense and Avoid system operations, local terrain	some under FAR 91, 10,34,37,40, 179?
157		Checklist and system use, including aircraft sensors	10,40, 168?, 172?
158		Recognize radio instructions	17,38, 178
159		Ability to recognize Wake Turbulence conditions and to accomplish avoidance procedures	40, 179, 81
160		Ability to monitor/control the UA during takeoff	54, 196
161		Recognize poor performance/ abnormal indications and perform abort/emergency procedures as dictated by the situation	45,54, 171?
162		System operation	10,40, 130, 131, 133, 134, 135, 136, 137,
163		ATC clearances and pilot/controller responsibilities	6,17,38, 178?
164		Limitations of aircraft in terms of the ability of the UA to comply with ATC messages	6,10,40, 578?
165		Procedures for requesting clarification, verification and changes	6,38,579
166		Frequency Management	176, 582, ??
167		Standard Phraseology for reading back clearances	6,17,38
168		Appropriate communications and navigation system transponder codes in compliance with the ATC clearance	6,17,38, 588
169		Copy and correctly interpret ATC messages	6,17,38, 577
170		Ability to operate radio and navigation equipment	10,19,40, 137
171		Standard Instrument Departure procedures	10,20,40
172		Aircraft best climb profile	10,40,54,195?
173		Wake Turbulence Avoidance Procedures	40, 81, 179
174		IFR and VFR flight procedures	123?, 576?, ?? Very broad and nebulous
175		Basic UA instrument monitor control	18, 348?, 349?
176		Skill in using AVCS interfaces to access required information	10,40
		ENROUTE	
177		Aircraft and avionic system performance monitoring requirements	34, 36, 40?, 43?, 348, 351, 356, 361, 366 686, 710
178		Procedures for identifying & resolving system problems	40, 379, 589, 604, 614, 621, 679, 685, 69
179		Unsafe flight attitudes and recovery procedures	44, 347, 364, 604, 656
180		Stall characteristics and stall recovery procedures	44, 79, 345, 346, 347, 604
181		Instrument crosscheck and interpretation procedures	40, 348, 351, 356, 361, 366, 603, 605, 62
182		Procedures for obtaining weather related data and using this data to decide whether a flight plan change is necessary	39, 503, 515, 516, 520, 677
183		Control UA	53, 54, 55, 56, 58, 59, 60, 61, 77, 78, 271 674, 676, 684, 688, 695, 706
184		Ability to interpret instruments for UA attitude, flight path and energy state	55, 59, 60, 349, 350, 352-355, 357-360, 3 604, 605, 608, 630, 679

185	Ability to interpret weather related information	47, 503, 515
186	Ability to change navigation log, if required	57, What is Nav LOG?
187	Procedures for maintaining contact with ATC	38, 576, 587
188	Procedures for changing frequencies to comply with ATC instructions	38, 576, 577, 582, 588, 620, 702
189	Procedures for communicating with ATC	38, 322, 576, 577, 580, 581, 585, 587, 59 640, 658, 660, 672, 698, 707, 708
190	Ability to speak clearly and concisely with proper terminology	32, 580, 581, 587, 618, 622, 640, 658
191	Ability to interpret radio communications	32, 675
192	Ability to operate radio and transponder	40, 53, 582, 675, 702
193	Procedures for acquiring weather and traffic information and for making decisions of whether these conditions will impact current flight plan	39, 41, 43, 47, 503, 515, 583, 599, 666
194	Weather Avoidance Criteria	39, 515
195	Windshear detection and avoidance procedures	39, 509, 623, 642
196	See and avoid concept	40
197	Access required weather information	47, 503, 515
198	Assess impact of weather on aircraft performance and navigation/flight plan	48, 503, 515, 623, 642, 665, 670
199	Perform required avoidance maneuvers within the capabilities of the UA	55, 60
200	Procedures for determining whether a flight plan change is required	39, 40, 44, 313, 318, 590, 612, 677
201	Procedures for changing the UASs flight plan	47, 48, 305, 313, 656, 657
202	Procedures for communicating flight plan changes to ATC	38, 47, 305, 322, 583, 656, 657, 658
203	Ability to respond to unplanned changes in a safe and efficient manner	40, 60
204	Procedures for accomplishing handoff	40, 77, 78
205	Procedures for transitioning between LOS and BLOS communications	40, 77, 78
206	Knowledge of Crew Resource Management (CRM) procedures	78
207	Ability to perform handoff	55, 57, 60, 78
208	Skill in applying CRM principles	53, 54, 55, 56, 57, 58, 59, 60, 61, 85
	MISSION OPERATIONS	
	reserved	
	DESCENT	
251	Procedures for acquiring weather information	9,11,39,105
252	Impact of weather on aircraft performance and landing operations	9,11
253	Using available resources to obtain required weather information	9,11,39,105
254	Skill in assessing impact of weather on aircraft performance	9,11,39,113?
255	Determine appropriate top of descent point	10,40
256	Ability to select and use the appropriate approach charts	8,20,57
257	Holding Pattern Procedures, and preferred method for entering holding patterns	7, 593 - 600
258	Procedures for monitoring/controlling the flight of the UA	18, 601 - 603

259		Instrument or Visual Approach procedures	20,54
260		Skill in monitoring/ controlling the flight of the UA	18, 601 - 603
261		Ability to use navigation equipment to follow designated flight plan	7,19, 305, 306, 307, 308
262		Holding pattern procedures, and preferred methods for entering holding patterns	7, 593 - 600
263		Procedures for controlling the UA in support of Holding Operations	7,18
264		Control UA while accomplishing standard, non-standard, published, or non-published holding patterns	7,10,18,40
265		Use proper wind correction procedures to maintain desired pattern & to arrive over the fix as close as possible to a specified time	7,10,18,40
266		Recognize arrival at the holding fix and to initiate prompt entry into the holding pattern	7,10,18,40
267		Comply with ATC reporting requirements	6,17,38,311
268		Procedures for monitoring/controlling UA heading, speed and altitude	18,57,59, 312, 370
269		Procedures for maintaining awareness of traffic and procedures for minimizing the potential for traffic conflicts (for both IMC and VMC conditions)	10,40,80?
270		Monitor/control UA to accomplish the appropriate approach procedure within given criteria	10,18,20,40
271		Skill in traffic awareness and conflict resolution procedures	10,40,80?
		ARRIVAL/APPROACH	
272		Elements related to an instrument approach	7,8,10,20, 576, 616, 638
273		Procedures to establish communications with ATC and the use of proper phraseology and technique	17,38, 311, 587, 618, 640, 702
274		Procedures for appropriate aircraft configuration and airspeed considering turbulence and windshear, if applicable	10,18,40, 202
275		Procedures for using navigation equipment to support the approach	8,10,19,20, 619, 645, 702
276		Necessary adjustments to published DH, MDA and visibility criteria	8,20
277		Missed approach procedures	8,20,54,653
278		UAS cross wind limitations, and procedures for landing in a Cross Wind	10,18,40,54,208
279		Monitor/control UAS to accomplish the appropriate approach procedure within given criteria	18
280		Recognize arrival at the holding fix and to initiate prompt entry into the holding pattern	7,18
281		Comply with ATC reporting requirements	17,38,588
282		Recognize if any flight instrumentation is inaccurate or inoperative, and to take the required remedial action	12,45 (also FAR 91), 621
283		Perform a Go-Around Procedure if conditions warrant	10,18,20,40,54,661
284		Ability to land in Cross Wind	10,40,54,208
285		Procedures for acquiring weather & traffic information & for making decisions of whether these conditions will impact current flight plan	9,39,47,48,105?
286		Procedures for changing flight plan to avoid weather/traffic	6,39,48
287		Weather Avoidance Criteria	10,40

288		Wake turbulence separation minimums and avoidance procedures	40, 81
289		Windshear detection and avoidance procedures	40
290		See and avoid concept	40 and FAR 91, 80
291		Minimum IFR/VFR weather visibilities and distances	4,8,20,34,39,123?
292		Access required weather information	9,39,105
293		Assess impact of weather on aircraft performance and landing operations	10,11,12,40,41,47,113?
294		Perform required avoidance maneuvers within the capabilities of the UA	18,40, 55
295		Skill in conflict/collision avoidance	18,40,55,80
296		Identify adequate visual reference to fly below minimum	20
297		Aircraft CG limits	10,40,127
298		Approach speed for fuel/aircraft weight	10,40
299		Landing configuration for weather (wind, ceiling, visibility)	10,39,40,54,129?
300		Unusual configuration for emergency approach and landing.	21,60
301		Crosswind landing procedures and aircraft limitations	10,40,54,208
302		Configuration management	10,40
303		Ability/skill to land with crosswinds up to the maximum allowable for the air vehicle	10,40,54,208
304		Missed Approach Procedure	18,20,54,633, 652, 653, 656, 657
305		Required Aircraft Configuration and Performance	?? Too broad maybe 10,40
306		Contingency Plan	?? Too broad
307		Recognize inadequate visual references	12,45
308		Comply with ATC-directed missed approach	17,18,54, 633, 659
309		Configure Aircraft for Missed Approach & Climb	10,40,54, 264, 265, 266, 633, 657
310		Perform Missed Approach Procedure	10,20,40, 633, 657
311		Proper go-around decisions & techniques	10,40,54, 262, 263, 661
		LANDING	
312		Landing gear operation	10,40,54,134
313		Minimum safe altitudes for crossing various types of terrain/airport obstructions	8,10,40,669
314		Skill in monitoring/controlling the flight of the UA	18, 203, 204, 206, 207, 674
315		Ability to use navigation equipment to follow designated flight plan	10,19,40
316		Same as taxiing before takeoff	?? Should this be removed?? Maybe 53
317		Exercise additional caution at unfamiliar destination airport.	53
318		Cross wind operations	53,54, 208, 672
319		Taxi procedures	53, 162, 163?, 164?, 165?, 166, 167
320		Ground operation of aircraft subsystems (engine, brakes, etc.).	10,40,53
321		Perform ground operations of aircraft to final parking.	53
		POSTFLIGHT GROUND OPERATIONS	
322		Taxi procedures.	53, 403, 404, 405
323		Aircraft ground operations.	53, 403, 404, 405, 406
324		Perform checklist actions	10,22,40, 408

325		Maneuver aircraft on the ground	53, 403, 404, 405, 406
326		Operate aircraft and sensor systems as necessary in preparation for engine shutdown.	10,22,40, 403, 407, 710?
327		Radio procedures	38
328		Communicate via voice in English.	32
329		Identify types and potential locations of known and suspected hazards	10,22,40,403
330		Knowledge of airfield operations	53, 403, 405, 406
331		Knowledge of local hazards as published in NOTAMS	15,51,53, 116, 121
332		Ability to detect potential Hazards	10,40,406
333		Skill in Hazard Avoidance	406, 10,40 similar
334		Position aircraft for future servicing and maintenance	403, 409, 53 (really a ground crew respo
335		Perform shutdown procedures	10,22,40, 403, 407
336		Park aircraft	53, 403, 406, 409